Materials

in Design Engineering

GUIDE TO FERROUS CASTINGS

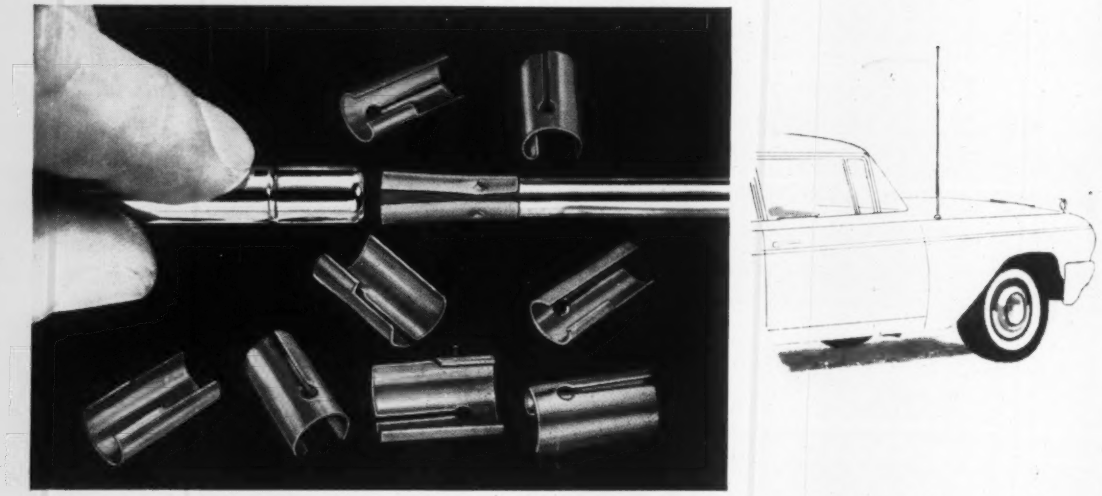
METAL SHOW PREVIEW

PRICE FIFTY CENTS

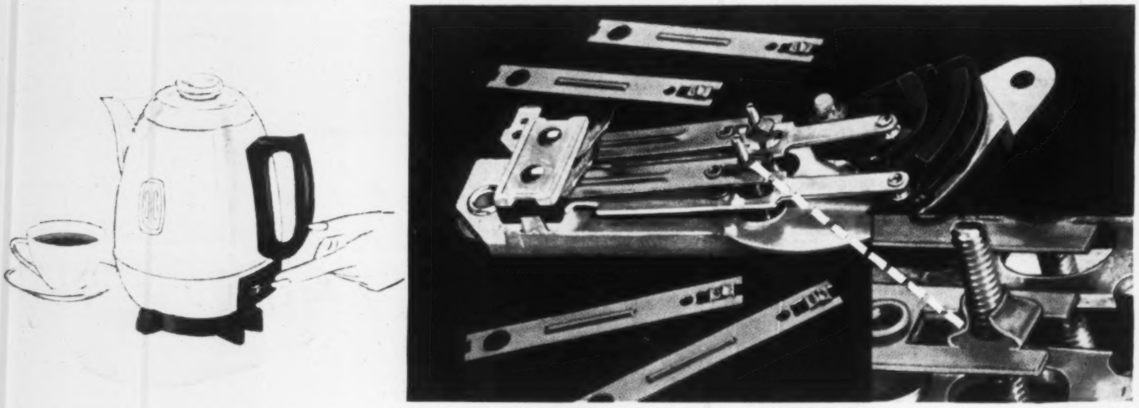
OCTOBER, 1960 WHAT'S NEW IN MATERIALS–P5 MATERIALS FOR PORTABLE REACTORS–P 107 COMPLETE CONTENTS–P 1

CREATIVE COST CUTTING

Selecting the metal to fit the job can give you surprising savings in total cost



Small spring clips between telescoping parts of auto radio antennas must maintain electrical contact, hold parts firmly, give smooth sliding action. **Brach Manufacturing Division of General Bronze Corp., Newark, N. J.,** found that spring clips of Duraflex®, Anaconda superfine-grain phosphor bronze, gave best positive electrical contact and improved smooth action in Brach Auto Antennas over original clips made of premium metals. The clips stand up in constant use, spot welding and fabrication are easier—and costs are about 25% lower.



In this G-E Automatic Coffee Maker control, **a thermostat turns cam actuating switches—for high heat to brew** coffee, for low heat to keep it warm. At first, upper switch element was an assembly of blade, bushing, and locking nut. **Tinnerman Products Inc., Cleveland, Ohio,** engineered a one-piece Speed Clip to replace it—by forming one thread in the blade and two prongs to lock the screw (see inset above). This simplification called for a superior phosphor bronze. Tinnerman found it in Duraflex, Anaconda superfine-grain phosphor bronze. It has higher tensile strength and endurance limit for long-lasting dependability—greater formability for economical manufacture. The result: unit costs were cut— and G-E assembles controls faster, more easily.

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OCTOBER, 1960 | VOL. 52, NO. 4

Materials
in Design Engineering

FORMERLY MATERIALS & METHODS

APPLICATION OF METALS, NONMETALLICS, FORMS, FINISHES

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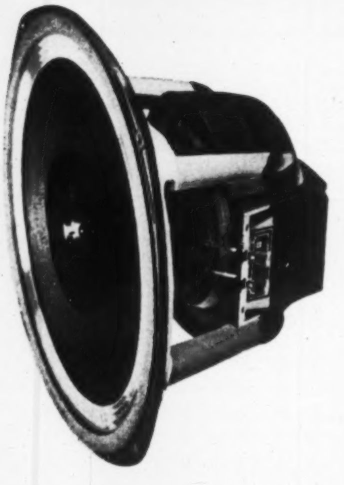

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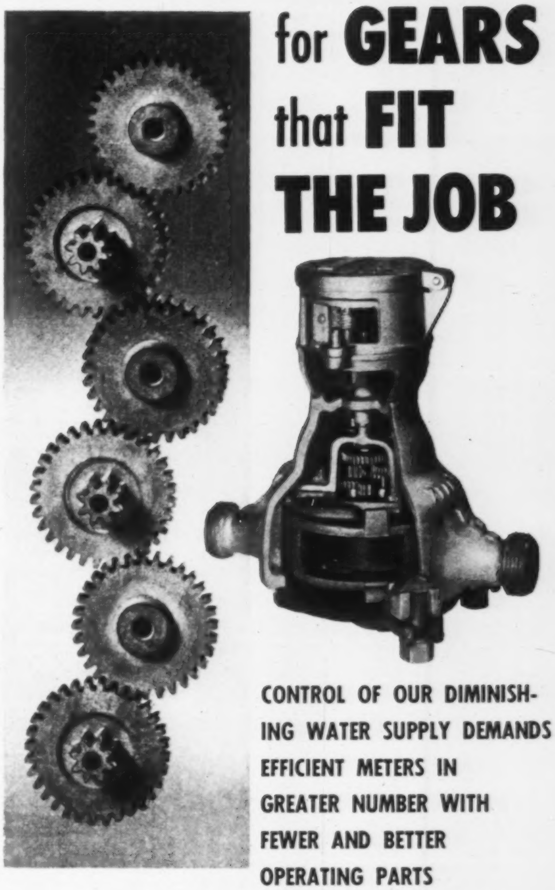

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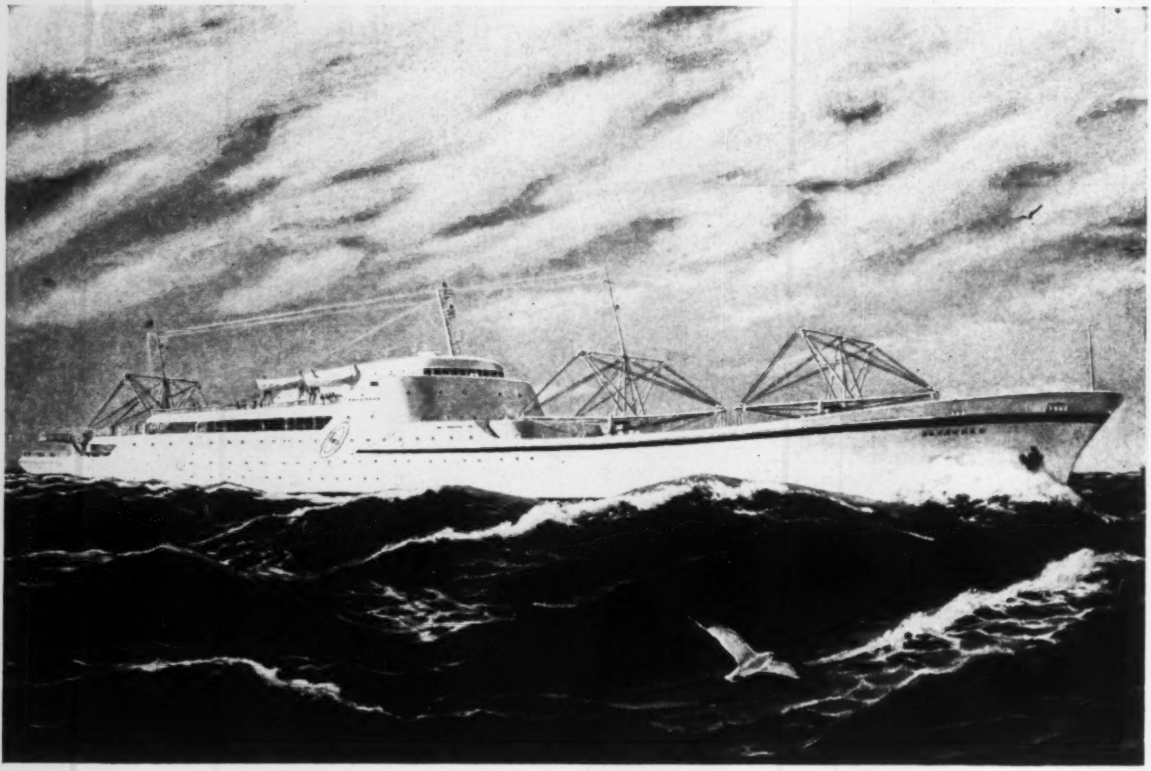

N. S. Savannah, built by New York Shipbuilding Corporation, can sail for three years on 138 pounds of nuclear fuel. A conventional ship would burn 80,000 tons of oil.

'round the world 13 times with fuel to spare ...the first nuclear-powered merchant ship

This is the Nuclear Ship Savannah, first of her kind. Capable of sailing over 350,000 nautical miles without re-fueling, she points the way to a new era in transport and travel at sea.

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At the design stage, engineers anticipated the high operating pressures – 1,750 pounds per square inch – and temperatures up to 508 °F. They selected Nickel Stainless Steels to provide the strength and resistance to heat and corrosion needed to withstand these rigorous conditions.

So the next time you need more from a metal, remember the N.S. Savannah. Nickel Stainless Steel, or another Nickel alloy, may be the solution to *your* problem, too.

A note to Inco will bring you "First Steps Towards Solving Specific Corrosion Problems" and "High Temperature Worksheet"... simplified forms you can use to describe your metal problem. Perhaps our technical staff has information that will help you find the solution.

Inside the reactor nearly everything you see is Nickel Stainless Steel to withstand corrosion, high temperatures and pressures that hit 1,750 psi. Reactor built by Babcock & Wilcox Co., Barberton, Ohio.

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What's new IN MATERIALS

...AT A GLANCE

Recrystallized graphite, with two to three times the high temperature strength of conventional graphites, joins two other graphites introduced in recent months (see M/DE, Feb '60, p 16 and Aug '60, p 165). The newer graphite is made by what is claimed to be a revolutionary hot working process that is more akin to metallurgical than ceramic technology. In recent rocket motor tests, nozzles made of recrystallized graphite proved to be as good as, and in some instances substantially better than, other high temperature materials such as tungsten and pyrolytic graphite. (More details next month.)

Source: National Carbon Co., Div. of Union Carbide Corp., 100 E. 42nd St., New York 17.

A new leaded nickel-copper alloy is said to have good corrosion resistance, high tensile and yield strengths, high electrical conductivity, and free machining characteristics. The precipitation-hardening alloy is suitable for electrical contacts, connectors and other electrical and electronic parts. It is presently supplied in round rod 3/32 to 1¼ in. in dia.

Source: American Brass Co., Waterbury, Conn.

Stronger and longer-lasting wood products can be obtained by using a new carbon steel thread insert that is said to produce a fastening system with twice the holding power of standard wood fasteners. Reason: its pitch, which is twice as large as that of standard machine screws, leaves thick sections of wood between threads and eliminates the breaking-up of wood fibers.

Source: Heli-Coil Corp., Shelter Rock Lane, Danbury, Conn.

A new tooling material—magnesium phototemplate and layout sheet—is available in widths up to 60 in., in lengths up to 168 in., and in thicknesses up to 0.090 in. The material is said to be extremely flat, easy to machine, lightweight, and dimensionally stable. It can be used for both the diazo and blueprint methods of reproduction.

Source: Dow Metal Products Co., Div. of Dow Chemical Co., Midland, Mich.

A dry lubricant in the form of TFE powder is now available. The new lubricant can be used on wood, ferrous and nonferrous metals, plastics, glass, leather and other materials. It is said to be odorless, colorless, tasteless, nonstaining, and suitable for use over the temperature range –450 to 400 F.

Source: Polydoris Products Corp., 5306 W. Lawrence Ave., Chicago 30.

Closer tolerance and lower cost corrugated metal is promised with the development of a new process in which ferrous or nonferrous metals are folded, rather than drawn, into corrugations. The developer says die costs range from $800 for a simple design to $3500 for a complex design. Folded aluminum, brass, copper, and carbon and stainless steels can be supplied in gages ranging from 0.002 to 0.030 in. at a tolerance of ±0.001 in.

Source: Twin Coach Co., 30 S. Cayuga Rd., Buffalo, N. Y.

Colored titanium parts are being turned out by a new process (details not disclosed) in which the metal is coated in brilliant and uniform colors without the use of harmful dyes or paints. The developer says colors can be applied to all titanium alloys. The colored coatings are durable and have good resistance to fading at temperatures up to 600 F. They are expected to be used for decorative purposes on commercial products and as identification on fasteners, valves, nuclear reactor parts, and pipes and fittings.

Source: Hi-Shear Corp., 2600 W. 247th St., Torrance, Calif.

A new flux-coated silver brazing alloy is said to permit the joining of ferrous and nonferrous metals at a speed three times faster than with conventional silver brazing alloys. Reason: the new product eliminates the need for a separate flux which has to be mixed, applied and dried separately before the application of a conventional brazing alloy. The developer says deposits are cadmium-free, and thus the brazing alloy can be used safely on processing equipment.

Source: Eutectic Welding Alloys Corp., Flushing, N. Y.

Three new man-made fibers that have no counterparts in the Western world have been produced in Russia, according to a recent report. The fibers are: 1) Enant, a nylon 7; 2) Ftorlon, a fluorine-containing copolymer with good chemical resistance; and 3) Vinitron, a combination of a cellulosic material with chlorinated polyvinyl chloride.

Source: R. C. Laible, Headquarters, Quartermaster Research and Engineering Command, Natick, Mass.

A new radiation resistant material—pure gold laminated to rubber-coated nylon—is now available in the form of continuous rolls measuring 36 in. wide by 100 yd long. The gold-nylon laminate can be fabricated into parts for use in electronic devices and missiles.

Source: Lamart Corp., 16 Richmond St., Clifton, N. J.

Magnesium castings can be sealed and primed in one operation by using a new type anodize treatment. The developer says castings sealed by the process withstand air or water pressures of at least 40 psi, and heating to at least 700 F. Sealed castings also withstand high humidity, and are stable in hot engine oil, gasoline and kerosene.

Source: Dow Metal Products Co., Div. of Dow Chemical Co., Midland, Mich.

Thinner tin plate, about half the thickness of tin plate now used in can making, is presently available in weights of 45 through 60 lb per base box. Big advantages of the new tin plate are its greater strength, lighter weight and lower materials cost compared to currently used tin plate.

Source: United States Steel Corp., 525 Wm. Penn Pl., Pittsburgh 30

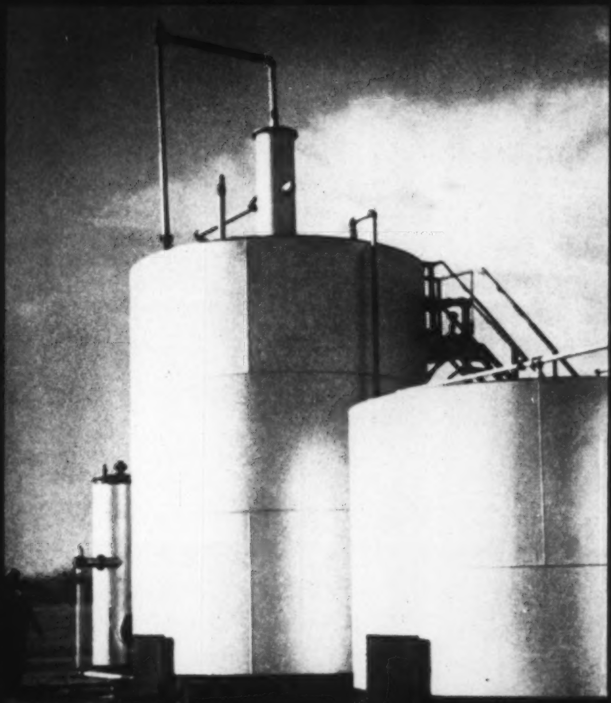
A new nickel-aluminum coating is said to protect ferrous and nonferrous metals from oxidation at temperatures up to 1800 F. The coating is obtained by electroplating nickel over the base metal and then electroplating aluminum over the nickel layer. Steel specimens protected with the composite metal coating have withstood 300 hr in salt spray tests before showing rust, according to the developer. (More details next month.)

Source: D. E. Couch, National Bureau of Standards, Electrodeposition Laboratory, Washington, D. C.

Turn to page 9 for more "What's New in Materials"

Another new development using

B.F.Goodrich Chemical ***raw materials***



Siphon separates oil from brine —no corrosion

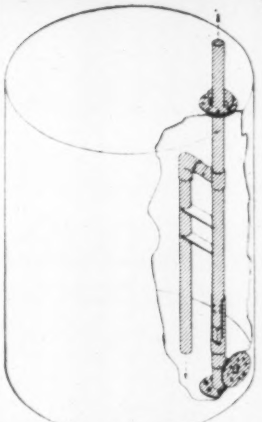
it's made of GEON

Either the oil or the salt water in these oilfield gathering tanks in Kansas can make short work of ordinary pipe. Now, with pipe and fittings fabricated of rigid Geon vinyl, there is no corrosion problem at all. Geon solved another problem too: the buildup of paraffin, common in metal pipe, was eliminated.

Geon pipe proves ideal for a wide variety of applications because of its resistance to corrosion and its impact and tensile strength. Crews especially like its light weight and easy installation. Either solvent welding or threads can be used.

Here's another example of the way that Geon vinyl solves product problems—and opens new markets. For more information, write Dept. GV-5 B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Siphons are fabricated of piping and fittings of Geon by Green Contracting & Engineering Company, Wichita. B.F.Goodrich Chemical Company supplies the Geon vinyl.



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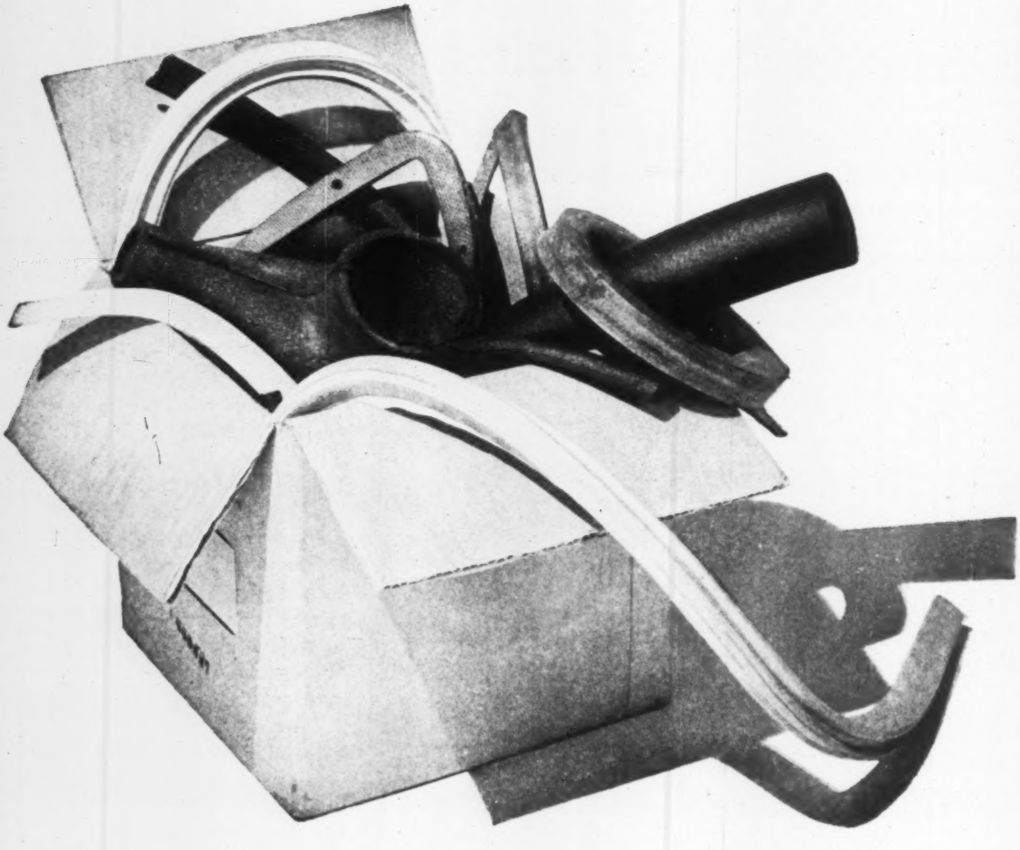

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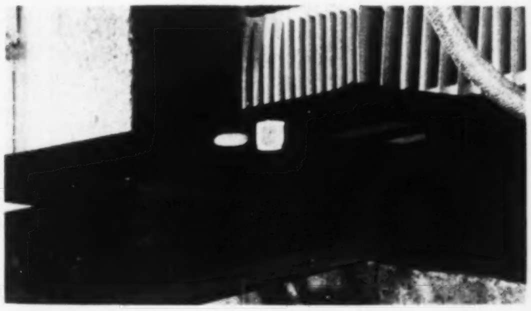
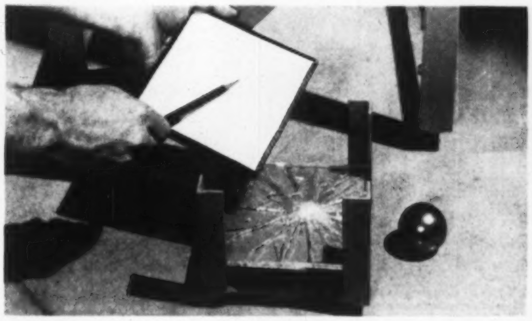
Fuse polycrystalline glass to metal and you get a

New Glass-Coated Metal for High Temperature Equipment

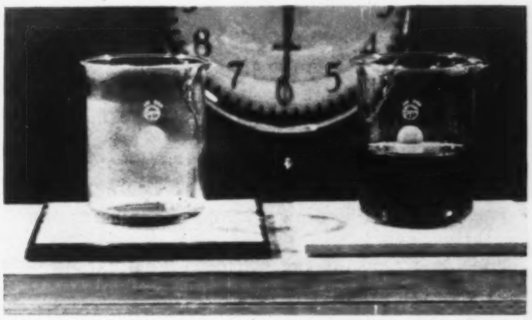


Heat resistance—*After 10 min at 1800 F a fusion button of soda lime glass (left) has "puddled"; button made of the ceramic component of Nucerite is unaffected.*

Thermal shock resistance—*Ice water is poured over a Nucerite specimen consisting of 0.020 in. of ceramic on 1/2 in. of mild steel which has just been heated for 15 min at 1250 F. No damage was visible.*



Impact strength—*Steel ball dropped from height sufficient to produce impact force of 10.8 ft-lb produces only slight crushing of outer surface, scarcely discernible at tip of pencil. Three-eighth inch safety plate glass shown is shattered by same loading.*



Thermal conductivity—*Both beakers originally contained 300 ml of colored water. The beaker at left was placed on Nucerite (0.020 in. ceramic on 3/8 in. Inconel), the beaker at right on 3/8 in. porcelain. Hot plate under both specimens was heated to 212 F. After 30 min, the beaker at left contains only 10 ml of water; the beaker at right contains 170 ml.*

■ A new process has been developed for ceramic coating of metals. The result is a composite consisting of a polycrystalline glass, a base metal, and a strong diffusion bond between them.

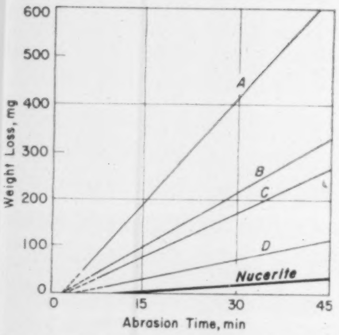
The polycrystalline glass, or ceramic, component of the composite is similar to Pyroceram (see M/DE, July '57, p 142).

Developed by Pfaudler Co., Div. of Pfaudler Permutit Inc., Rochester 3, N. Y., and trademarked Nucerite, the composite is primarily designed for use in chemical process equipment where operating conditions are too severe for glass-lined steel.

The new composite offers five major properties:

1. Heat resistance; e.g., it has protected molybdenum from oxidation at 1600 F.
2. Excellent thermal shock resistance; e.g., it withstands shocks produced by cycling over a 1200°F temperature differential.
3. Excellent abrasion resistance, e.g., it is said to be four times more resistant than laboratory glass (see Fig 1).
4. Thermal conductivity higher than that of hard glass and most other high temperature ceramics (see Fig 2).
5. Good impact strength.

In addition to uses in chemical processing equipment, such as reactor vessels and heat exchanger tubing, the coating is said to offer promise as a protective coating for the reactive metals, and for



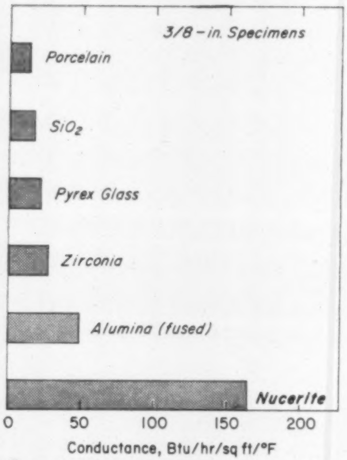
1—Abrasion resistance *of Nucerite is compared with that of four enamels by the standard PEI abrasion test.* (Curves for enamels from Proceedings PEI Forum, 1954.)

use in mechanical seals and bearings. Design limitations are virtually identical to those of glass-lined steel.

According to Pfaudler, a number of glass compositions are available to match the desired base metal in thermal expansion. Metals to which the coating can be applied include: conventional carbon steels; high nickel alloys, such as Inconel or Hastelloy; and the reactive metals, such as tantalum, columbium or molybdenum.

How the composite is made

The selected glass, containing nucleating agents, is applied to the metal by any of the conventional methods used to glass-line steel, e.g., wet spray, slushing or hot dust. After a ground coat has been applied it is fused to the metal, producing a diffusion bond. Subsequent layers of glass are applied and fused until sufficient thickness is built up. The final glass-metal composite is then heat treated.



2—Heat transfer rate *for 3/8-in. thick specimens of Nucerite is much higher than that of the same thicknesses of other ceramic materials.*

During heat treatment the nucleating agents form submicroscopic crystallites, each crystallite acting as a center of crystal growth as the heat continues. The end product is a fine-grained crystalline coating.

The internal structure of the coating is not completely understood as yet, according to C. L. Betzer, Pfaudler's technical manager. At the metal-ceramic interface there is definitely reciprocal diffusion producing a cermet phase of unidentified composition. Within the ceramic coating the crystalline areas are, to some degree, laminar.

Although overall crystalline content of the ceramic component is about 30-50%, crystalline concentration is greater at interfacial areas between subsequently applied layers of glass. This laminar affect is thought to be due to some migration of nucleating agents to surfaces during application of the coating.

Availability, cost

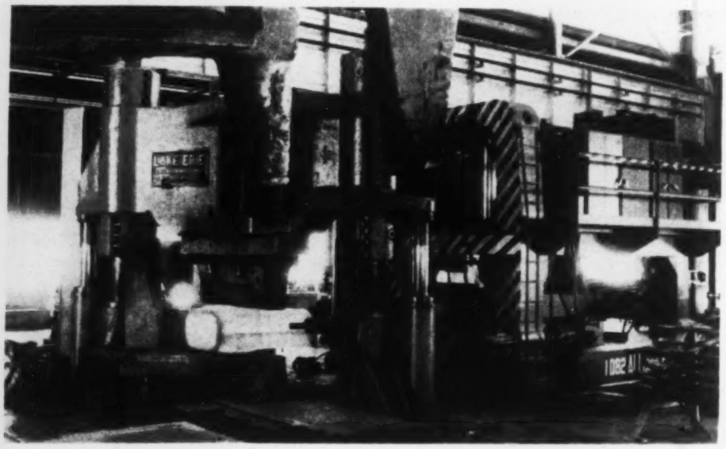
All Nucerite will be custom fabricated by Pfaudler. Although the company has successfully coated and tested a variety of parts, the process is still somewhat developmental. At present an extended evaluation period of selected field testing is planned.

Costs are difficult to estimate now. In general, however, Nucerite will be more expensive than glass-lined steel.

For more information, circle No. 600

Large Tool Steel Forgings

New forging press *handles 30,000-lb forgings*



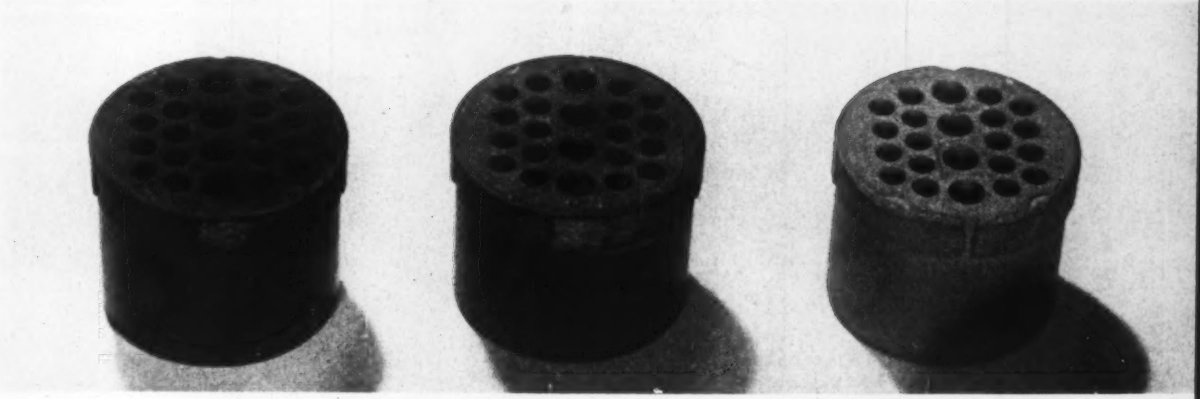
■ Allegheny-Ludlum Steel Corp. recently installed a new forging shop at its Dunkirk, N. Y. plant to handle hard-to-work alloys such as tool steels, stainless steels and high temperature alloys.

Principal feature of the new forge shop is a 2000-ton, general purpose oil hydraulic forging press (see photograph). Only two columns support the overhead structure of the press and these are arranged diagonally to allow forging of wider pieces.

Ingots weighing up to 30,000 lb can be forged on the new press. Tool steel structural parts for supersonic aircraft have already been forged. Disks for extrusion dies have been forged in sizes up to 42 in. dia and 26 in. thick.

High temperature connectors *use inserts molded of the new silicone compound.*

Amphenol-Borg Electronics Corp.



Moldings retain form *when heated.* Left—*Insert as molded.* Center—*After 2 hr at 700 F, 18 hr at 800 F, 2 hr at 900 F, and 15 min at 1000 F.* Right—*After direct firing for 6 hr at 1100 F.*

New Molding Compound for 700 F Electrical Uses

■ A new mineral-filled silicone molding compound, primarily designed for high temperature electrical insulation, features: 1) long-term stability at 700 F, 2) excellent thermal shock resistance (over a range of −67 to 500 F), 3) a low dissipation factor of 0.002 at 10^6 cps, and 4) arc resistance greater than 400 sec.

This compression or transfer molding compound, designated M-6-4156, was developed by Dow Corning Corp., Midland, Mich., in cooperation with Amphenol-Borg Electronics Corp., research personnel to meet the most stringent high temperature requirements of advance connector design. Other promising applications include fuses, coil forms, relay parts, tube bases, contactors, arc barriers and switch parts.

The material is currently being produced in semicommercial quantities, and is available at a developmental price of $5.50 in 300-lb quantities.

Properties

The tables on the next page list typical properties of the compound, both postcured and after thermal aging at various temperatures.

A curious characteristic of the material is its form stability at temperatures of over 2500 F. At such temperatures the organic constituents have evidently burned off, leaving a ceramic-like silica body. Unfortunately, the body is quite porous, which limits its utility. Development work is now aimed at reducing such porosity. Data given in the table for specimens aged 3 hr at 1800 F indicate the properties of the material in its ceramic-like form.

Amphenol connectors first successful use

The compound was initially developed to meet the requirements of Amphenol-Borg Electronics Corp.'s high temperature (496 construction) AN/MS type connectors. According to V. Elarde, Director, Materials and Components Research, of Amphenol-Borg, the material has exceeded the original requirements.

Initial objective was to produce a connector serviceable for a minimum of 8 hr at 600 F. The compound also had to be usable with available production techniques and adaptable to existing tooling.

TYPICAL PROPERTIES OF MINERAL-FILLED SILICONE MOLDINGS

Condition ➡		Post-Cured[a]	After Aging[b]			
			72 Hr, 500 F	72 Hr, 700 F	72 Hr, 800 F	3 Hr, 1800 F
MECHANICAL PROPERTIES						
Flex Str, 1000 psi	D790	8	7.9	5	2.2	6
Flex Mod of Elast, 10^6 psi	D790	2.2	—	1.6	—	—
Compr Str, 1000 psi	D695	15	16.3	12	7.5	15.4
Compr Mod of Elast, 10^6 psi	D695	0.5	—	0.6	—	—
Ten Str, 1000 psi	D638	3.5	—	1.6	—	—
Izod Impact Str, ft-lb/in. notch	D256	0.35	0.40	0.38	0.43	0.49
PHYSICAL PROPERTIES						
Specific Gravity		2.82	2.82	—	2.73	2.68
Water Absorption (24 hr, 77 F), %	D570	0.13	0.05	0.19	2.0	7.7
Dimensional Stab (shrinkage), in./in.[c]		0.0044	0.0022	—	0.006	0.019
Weight Loss, %		—	1.3	—	5.08	8.15
Heat Dist Temp (264 psi), F	D648	>900 F	—	>900 F	—	—
Flammability	D635	Self-extinguishing				
ELECTRICAL PROPERTIES						
Arc Resistance, sec	D495	420	420	420	420	420
Dielectric Str, v/mil						
Air	D149	200[e]	>207	210[e]	>210	52
Oil	D149	400	389	325	279	133
Vol Resistivity, ohm-cm						
Dry	D257	3.6×10^{14}	3.6×10^{14}	4.6×10^{12}	2.2×10^{11}	9.5×10^{13}
Wet[d]	D257	8.5×10^{13}	8.5×10^{13}	5.5×10^{10}	—	—
Ins Resistance, ohms						
Dry		3.3×10^{14}	—	1.23×10^{12}	—	—
Wet[d]		3.35×10^{12}	—	5.23×10^{10}	—	—

[a] Two hours at 500 F. [b] Tested at 77 F.

[c] Molding and postcure shrinkage is 0.0044 in./in. Values given after aging indicate additional shrinkage caused by soak at temperature.

[d] 24-hr immersion in water at 73 F. [e] After 96 hr at 73 F and 96% RH.

TABLE 2—ELECTRICAL PROPERTIES

Dielectric Constant[a]	
Dry	
60 Cps	6.4
10^6 Cps	6.3
Wet[b]	
60 Cps	6.4
10^6 Cps	6.3
Dissipation Factor[a]	
Dry	
60 Cps	0.003
10^6 Cps	0.002
Wet[b]	
60 Cps	0.004
10^6 Cps	0.002

[a] ASTM D150.

[b] 24-hr immersion in water at 73 F.

The resulting compound is said to offer a considerable margin of improvement in both thermal shock resistance and thermal stability. Mr. Elarde points out the following performance improvements:

- Compound does not crack during thermal cycling.
- Inserts made with the compound perform well for several hundred hours at 700 F—much longer and at 100 °F higher temperature than required.
- Inserts can be molded easily by conventional compression or transfer molding techniques.

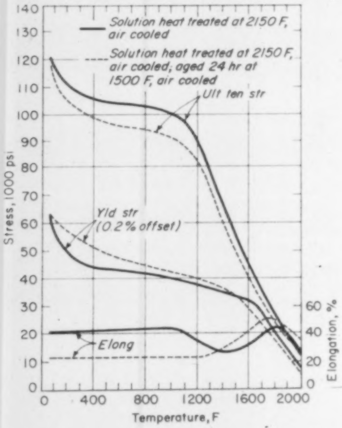
Although performance data are incomplete as yet, insulation resistance vs temperature is as follows (values in kilomegohms):

Temp, F	
Room	2000
300	1500
400	1500
460	1500
1000	1

These data were obtained using 1/16-in. dia electrodes spaced 3/16 in. apart in a 1/16-in. specimen.

For more information, circle No. 601

High Strength, Oxidation Resistant Alloy



***Mechanical properties** of 0.063-in. thick sheet of Haynes 56 alloy.*

■ Haynes 56, an alloy of chromium, nickel, cobalt and iron, has been announced by Haynes Stellite Co., 270 Park Ave., New York 17, N. Y. The alloy has good oxidation resistance: in continuous exposure to dry air for 100 hr at 1900 F its oxidation rate was only 0.024 in. per year.

Nominal composition of the alloy is: nickel, 13%; cobalt, 11.5%; chromium, 21%; molybdenum, 4.5%; tungsten, 1.5%. Small amounts of carbon, nitrogen, columbian, silicon and manganese are also present. Since the alloy is solid solution strengthened, no further heat treatment is necessary after solution treatment at 2150 F.

Mechanical properties of Haynes 56 are shown in the accompanying graph.

Haynes 56 is available as sheet, bar, wire and coated welding electrodes. Parts can also be produced by sand, investment and shell casting techniques.

For more information, circle No. 602

Fusion welding columbium *is done in an inert atmosphere. This chamber houses standard inert-gas shielded arc welding equipment and the copper tooling fixtures for positioning work (shown above).*

Welding and Brazing Two Columbium Alloys

Two high temperature alloys have been joined by fusion and resistance welding, as well as brazing, for aircraft and missile applications. Here are joining procedures and the joint properties obtained.

by C. F. Burrows, M. M. Schwartz and L. J. Gagola,
Baltimore Div., Martin Co.

■ Research engineers at Martin Co.'s Baltimore Div. have successfully joined columbium alloys by fusion and resistance welding and brazing. These refractory alloys have been developed for use in missiles and space vehicles where operating temperatures will be as high as 3000 F. The goal was to weld and braze honeycomb structures from thin sheet stock. The two columbium alloys used were Fansteel 82 (33 tantalum–0.7 zirconium) and Du Pont D31 (10 titanium–10 molybdenum).

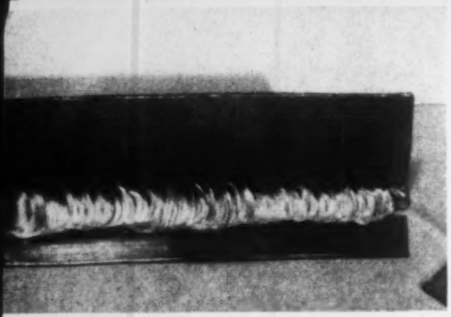
The difficult joining problem

Joining columbium and its alloys requires more exacting process control than required for standard structural metals. Problems affecting the fusion of these refractory alloys are:

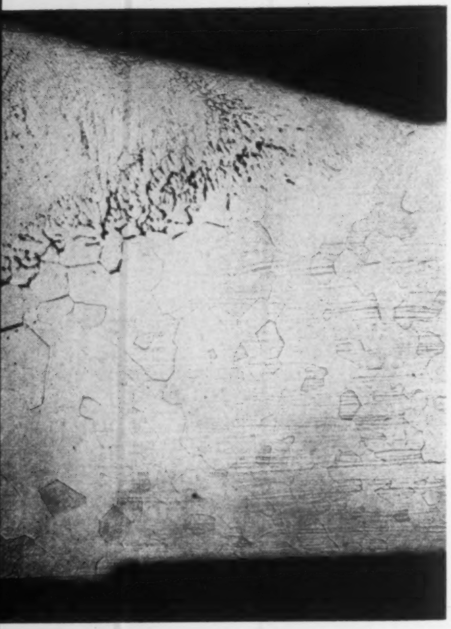
High melting temperatures—Fansteel 82 and Du Pont D31 melt at 4550 F and 4100 F respectively. These temperatures require considerable heat or welding current to melt and flow the metal. Therefore, it is particularly difficult to weld thin gages where burn through is apt to occur. High welding currents concentrated long enough to get melting also create thermal gradients within the metal and cause distortion.

Gas absorption—Columbium and its alloys pick up interstitial impurities (hydrogen, oxygen, nitrogen and carbon) when exposed to high temperatures. These embrittle the base metal, fusion zone and heat-affected area.

Recrystallization and grain growth—The molten weld metal on solidification will form large dendritic grains, with recrystallization occurring in the heat-affected zone when heating time and amount of previous cold working permit. Recrystallization, which occurs on heating columbium above about 1800 F, removes the effects of cold working and thereby lowers mechanical properties.



1—T-joint *fusion weld made with 0.032-in. Fansteel 82 columbium.*



2—Brittle precipitate *in fusion butt welded D31 appears as the dark areas (left) between the weld bead and the base metal (65X).*

TABLE 1—MECHANICAL PROPERTIES OF FUSION WELDED FANSTEEL 82 (0.032-In. Sheet)

Properties	Control (unwelded)	Weld Panel 1	Weld Panel 2
Ult Str, psi	68,480	65,580	58,520
Yld Str, psi	49,210	44,460	36,890
Elong (in 2 in.), %	13	9.2	14
Mod of Elast, 10^6 psi	17.4	14.9	17.2
Failure Location	—	Parent metal	
Bend Test	No cracking when specimens were bent 180° using a punch radius as small as 0.315 in.		

Fusion welding

Weldability

Fansteel 82—The fusion weldability of Fansteel 82 is superior to that of conventional stainless steel alloys known for their good welding characteristics. Typical butt and T-joints were successfully prepared from sheet gages ranging from 0.002 in. to 0.032 in. The metal, whether consisting of melted edges or added filler wire, flowed readily and made smooth welds. Occasional weld metal depression, or "suck back," occurred on the penetration side of fillet welds in 0.032-in. T-joints. Caused by high heat input and metal thinness, it can be minimized by a welder experienced in controlling heating or by increasing the metal gage.

Fig 1 shows typical T-welds in 0.032-in. Fansteel 82. Mechanical properties of the test welds are given in Table 1.

Du Pont D31—Du Pont D31 is weldable but it has a strong tendency to crack. Examination of three welded specimens (two cracked between the weld bead and the heated zone; the third did not crack) showed a dendritic cast zone with either solid solution melting or precipitate in the melt-metal junction. High temperature diffusion techniques were tried, with varying success, to eliminate this brittle precipitate (shown in Fig 2). Further investigations are being conducted by Martin Co. and Du Pont Research Laboratories to determine if D31 columbium has merit as a structural high-temperature material.

Welding technique

Since columbium and its alloys are very sensitive to interstitial contamination, the fusion welding was done in a chamber that was effectively purged by an inert atmosphere. Dried argon, dried helium, and mixtures of the two gases were used in the chamber and in the torch. Helium was preferred because it provides better purging and gives a hotter arc. The welder was a standard tungsten arc unit using a d.c. power source and a 3/32-in. dia tungsten electrode. The chamber and positioning fixtures are shown in the photograph at the beginning of this article.

Plates to be welded were positioned between copper tooling fixtures and the chamber purged until all evidence of oxygen contamination was eliminated. Atmospheric purity was checked by welding scrap titanium until the weld showed a clear bright surface. When the chamber was purged, gas flow in the chamber was adjusted to 30 cu ft per hr and in the torch to 10 cu ft per hr.

Resistance welding

Weldability

Resistance welding studies were made on 0.002, 0.005, 0.010 and 0.032-in. Fansteel 82 and on 0.040-in. Du Pont D31.

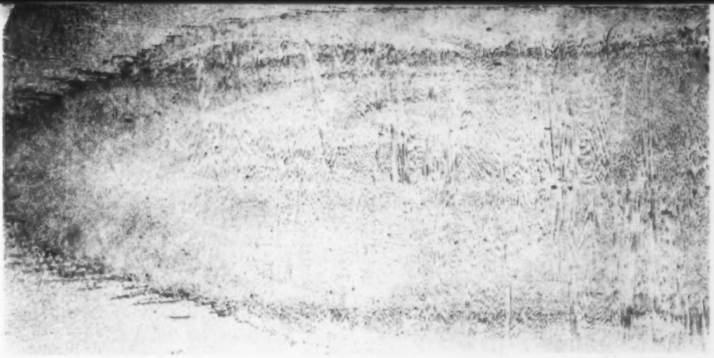
Fansteel 82—Sheets of Fansteel 82 were easier to resistance weld than commercially pure columbium. Less electrode-to-metal sticking occurred so more welds could be made before redressing the tips. In addition, the weld zone was more ductile and showed less evidence of sheet interface in the welds.

Spot welded surfaces tended to discolor and show evidence of considerable copper pickup. The electrode tip frequently had to be cleaned and reshaped to prevent sticking.

Characteristics of the various foil thicknesses:

0.002 in.—Frequent cleaning or redressing of the electrode was required to overcome sticking and tearing.

0.005 in.—Showed polycrystalline grain size but the foil inter-



3—Spotweld *in Du Pont D31 columbium sheets. Weld nugget shows the effect of multiple impulse resistance welding; note fine grain formation next to coarser structure (55X).*

face line could not be removed. Average shear strength was 60 lb with pull-out from both foils.

0.010 in.—Some inconsistency because of electrode deterioration. The first three welds made with clean class 2 copper tips had a shear strength of 140 lb with button pull-out from one or both surfaces.

0.032 in.—Weld structure was good. Average shear strength was 862 lb for welds made with class 1 copper electrodes and 916 lb for those made with class 2. The softer class 1 tips tended to mushroom easily, but even with the harder class 2 tips redressing was necessary after every five spots.

Du Pont D31—Resistance welding Du Pont D31 was not successful when the settings used for Fansteel 82 were used. Multiple impulse welding, however, eliminated much of the electrode sticking problem. Less power is used for multiple welds, and cooling between impulses further reduces sticking. Sheets of 0.040-in. D31 were successfully spot welded. Note the fine-grain weld layer in Fig 3. No shear tests were made because of the shortage of material.

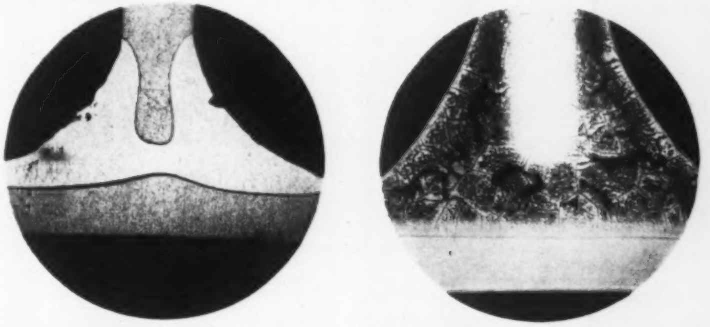
Welding technique

Fansteel 82 foil was shaped and welded into honeycomb cores for brazing into sandwiches. Core nodes were welded with stainless steel equipment using a 100-kv power source. The bottom electrodes were ¼ in. copper fingers that also held the work. The top electrode was a copper wheel, hand drawn over the metal to make intermittent welds approximately 1/32 in. apart.

Brazing

The first brazing studies, conducted for Martin Co. by Du Pont's Experimental Station, used only pure titanium and platinum for brazing at 3300 F. Platinum eroded the base metal severely and produced a brittle joint. Titanium, however, alloyed slightly with the base and produced a strong ductile joint.

Subsequently, other brazing alloys were surveyed and five were selected for detailed investigation. These experiments were conducted by the National Research Equipment Corp. in a 4000 F cold-wall, vacuum furnace. Both Fansteel 82 and Du Pont D31 were brazed with each of the five alloys. Results are shown in Table 2.



4—Two brazed joints. *Unsuccessful joint at left was made with 90 platinum-10 rhodium alloy. Successful joint at right was made with titanium. The titanium alloyed slightly with columbium, but the platinum-rhodium eroded the base metal (20X).*

TABLE 2—BRAZING FANSTEEL 82 AND DU PONT D31 COLUMBIUM

Brazing Alloy	Brazing Temp, F	Results
Palladium	2900	Slightly dissolves base; brittle joint
Platinum	3300	Same as above
Titanium	3300	Slightly dissolves base; strong, ductile joint
90% Platinum—10% Iridium	3300	Slightly dissolves base; brittle joint
90% Platinum–10% Rhodium	3450	Severe erosion; very brittle joint

In general, test results look very promising. Of the brazing alloys being evaluated only 90 platinum–10 rhodium has been eliminated. Titanium still appears to be the best brazing alloy for columbium. Fig 4 is a micrographic comparison of a platinum-rhodium joint and a joint made with titanium.

Brazing studies are continuing with the new Martin Co. high temperature furnace, one of the largest in the country, which has an operating temperature of 4200 F.

Temperature *of ceramic exposed to oxyacetylene flame is measured as part of program to determine thermal shock resistance and high temperature strength.*

Low Thermal Expansion + High Melting Point = High Temperature Structural Ceramics

by F. H. Simpson, *Aero-Space Div., Boeing Airplane Co.*

■ A new family of hafnium titanate ceramics now under development combines low thermal expansion with an unusually high melting point. Thus, the materials look highly promising for high temperature structural applications.

In certain composition ranges (i.e., molar ratios of 2 to 1) the materials offer:

- ▶ Coefficients of thermal expansion ranging from –5 to 5 × 10^{-7} per °F, over a temperature range of 0-1800 F.
- ▶ A melting point of about 4000 F.

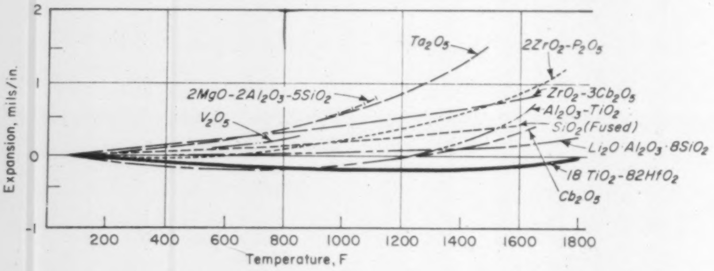
At present, maximum use temperature is limited by an apparent phase change occurring in the material at about 3400 F. Current work is aimed at modifying compositions to prevent this phase change, so that hot face use temperatures can be extended to the melting point.

The thermal expansion characteristics of the new materials are not unique, as shown by the expansion curves for a variety of low expansion ceramics in Fig 1. However, compared with other low expansion ceramics, hafnium titanates have an exceptionally high use temperature, as shown in Table 1.

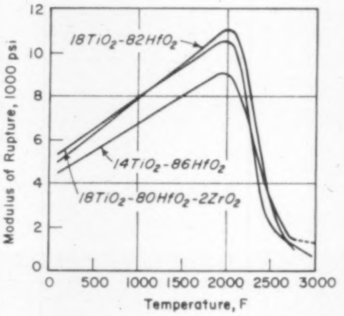
Effects of temperature on strength of three typical hafnium titanates are shown in Fig 2. Both the relatively low order of magnitude of strength, as well as the initial increase of strength with increasing temperature, are typical of low expansion ceramics in general.

Variety of compositions

Effects of altering titania-hafnia proportions on thermal expansion are shown in Fig 3. Compositions containing from 14 to 19% titania produce the very low and negative expansions. The irregular order of the expansion of



1—*Thermal expansion of the new materials compared with that of other low expansion ceramics.*



2—*Strength vs temperature for three typical hafnium titanates. Increase of strength with temperature to an upper critical temperature is typical of behavior of low expansion ceramic materials.*

Adapted from a paper presented at the American Ceramic Society's Pacific Coast Regional Meeting, Oct '59.

these bodies with changing compositions is probably due to slight variations in the thermal histories of the specimens; specimens were prepared over a several months' period in different Globar furnaces. Also, specimens sintered at temperatures higher than 2750 F had slightly lower expansivities.

To determine whether expensive high purity hafnia is necessary in preparing the compositions, varying proportions of zirconia were added to the hafnium titanate bodies. Additions of zirconia were found to decrease thermal expansion, as shown in Fig 4. Density also decreases with increasing zirconia content, as would be expected due to the lower density of zirconia. Little change in porosity occurred; an addition of 2% zirconia produced the body of lowest porosity.

Table 2 shows properties of three representative bodies, one of which is the 2% zirconia body. These specimens were fired at 2200 F on a 24-hr cycle. The bars were then ground, polished and refired on a 48-hr cycle to 2800 F in a Globar kiln, the furnace being held at 2800 F for 4 hr.

Elastic moduli, calculated from

TABLE 2—PROPERTIES OF THREE TYPICAL HAFNIUM TITANATES

Type ➡	A	B	Cμ
Composition, %			
HfO_2	82	86	80
TiO_2	18	14	18
ZrO_2	....	....	2
Sintering Temperature F	2800	2800	2800
Density, lb/cu in	0.26	0.26	0.26]
Apparent Porosity, %	3.91	5.0	3.8
Linear Fired Shrinkage, %	20.3	20.3	20.1
Coef of Therm Exp (80-1800 F) 10^7 per °F	2.6	−10.8	−5.4
Mod of Elast 10^6 psi	3.15	2.34	2.71
Mod of Rupture, psi			
Original (RT)	4925	4420	5280
Air Quench (5 cycles)[a]	5370[b]	3750	4600
Water Quench[a]			
1 Cycle	500	800	565
5 Cycle	500	595[c]	505

[a] Cycling from room temperature to 2500 F and back.

[b] Data from only one specimen; may not be significant.

[c] Two or three specimens broke in handling.

TABLE 1—COMPARATIVE THERMAL PROPERTIES OF LOW EXPANSION CERAMICS

Material	Melting Point, F	Upper Use Temp, F	Coef of Linear Ther Exp, 10^7 Per °F	Remarks
$xTiO_2 \cdot yHfO_2$	Approx 4000	3200-3400	−5 to +5 (70-1800) F)	An apparent phase change takes place near 3400 F
SiO_2 (fused)	3133[a]	1800	2.8 (70-1200 F)[b]	Devitrifies on heating above 1800 F
$xAl_2O_3 \cdot yTiO_2$	Approx 3370[c]	2150-2350[d]	−2.7 to +9.7 (70-1700 F)[e]	Dissociates if held between 2150 and 2350 F for 10 to 30 hr
$xLi_2O \cdot yAl_2O_3 \cdot 2SiO_2$	Approx 2300-2600[c]	2300	−5 to +5 (70-1100 F)	—
$ZrO_2 \cdot 3Cb_2O_5$	—	2500	5.7 (70-1600 F)[b]	—
$2ZrO_2 \cdot P_2O_5$	—	2800[f]	7.2 (70-1700 F)[f]	Dissociates slowly above 2800 F
$2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$	2678[d]	2678	7.2 (70-720 F)[b]	Melts incongruently at 2678 F
Ta_2O_5	3310[g]	3310	11 (70-1450 F)[b]	—
V_2O_5	1274[h]	1274	3.5 (70-800 F)[i]	—

[a] Campbell, I. E., *High Temperature Technology*, Wiley, '56.

[b] Durbin, E. A., and Harman, C. G., *An Appraisal of Sintering Behavior and Thermal Expansion of Some Columbites*, BMI 791, Dec 15, '52.

[c] Levin, E. M., et al, *Phase Diagrams for Ceramists*, American Ceramic Soc., '56.

[d] Hummel, F. A., "Ceramics for Thermal Shock Resistance," *Newer Ceramics*, Pennsylvania State University, reprinted from *Ceramic Industry*, 1955-56.

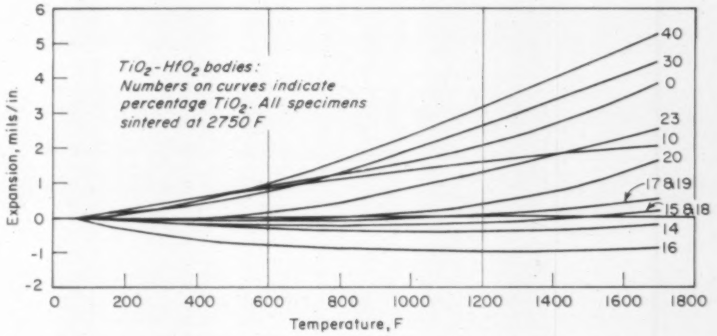
[e] Koch, W. R., and Harman, C. G., *Aluminum Titanate as a Ceramic Material*, AECD 3213, U. S. Atomic Energy Commission, Nov 20, '50.

[f] Harrison, D. E., et al, "High-Temperature Zirconium Phosphates," *Jnl. of the Am. Ceramic Soc.*, Vol. 37, No. 6, June '54, p 277.

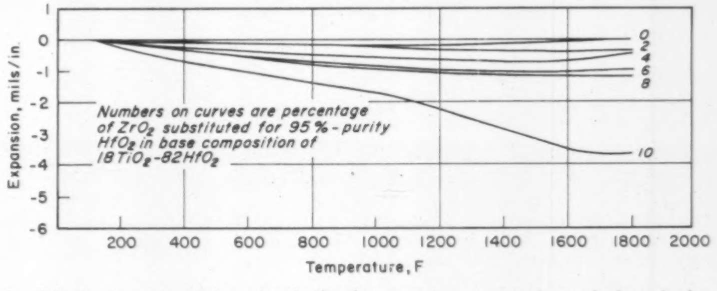
[g] Norton, F. N., *Refractories*, 3rd Ed., McGraw-Hill, '49.

[h] Hoelgman, C. D., *Handbook of Chemistry and Physics*, 31st Ed., Chemical Rubber Publisher Co., '49.

[i] King and Suber, "Some Properties of the Oxides of Vanadium and Their Compounds," *Jnl. of the Am. Ceramic Soc.*, Vol. 38, No. 9, Nov '55, pp 306-311.



3—*Effects of altering ratio of titania and hafnia on thermal expansion characteristics. Note very low and negative expansion compositions at bottom.*



4—*Effects on expansivity of substituting varying proportions of zirconia for hafnia in an 18 TiO_2-82 HfO_2 composition using 95% purity hafnia.*

deformation under given centerpoint loading on a 2-in. span, are low in comparison with those of most ceramic oxide bodies. Room temperature modulus of rupture is about that reported for lithium-aluminum-silicates and aluminum titanates.

Thermal shock resistance

Thermal shock resistance was determined by placing specimens in alundum boats, sliding them into the 2500 F hot zone of the furnace, and, after 10 min, drawing the specimens out of the furnace, and cooling either by air or water quenching. As shown in Table 2, air quenching for 5 cycles caused an approximate 13% decrease in modulus of rupture of compositions *B* and *C*. Only one specimen of composition *A* was tested, so results may not be significant.

Water quenching was definitely detrimental to the material. Little difference between one and five cycles was noted in the modulus of rupture values, but cracks appeared in the specimens after the third cycle. Sensitivity to rapid quenching is undoubtedly due to the hysteresis in expansion.

Modified Cellulose Film Has High Capacitance

Electroluminescence and microminiature capacitors are two known applications for this new dielectric. The material can be molded, too.

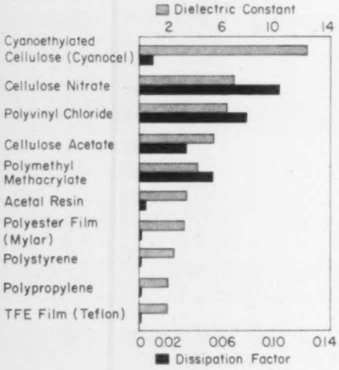
■ Newly developed cyanoethylated cellulose, trademarked Cyanocel, has the highest dielectric constant (12.5) of all known organic film-forming materials, according to its developer, American Cyanamid Co., 30 Rockefeller Plaza, New York 20. Coupled with this high K value, is a dissipation factor of less than 0.02, as shown in the accompanying bar chart. This combination provides an unusually high capacitance value—a capacitance per unit volume two to six times greater than that of comparable products, according to Cyanamid.

Transparent films have been produced in thicknesses ranging from 0.1 to 5 mils or more. The material can be cast onto any flat, smooth surface, such as glass or metal foil.

First commercial use of the material is said to be in an electro-

(more What's New on p 185)

Clarity *of film is evident in this sample.*



How Cyanocel compares *with other plastic film materials in dielectric constant and dissipation factor. Measurements were made at 60 cps, 110 v.*

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RCI POLYLITE Plastic Concrete Forms Cut Building Costs!

- "Reinforced plastic concrete forms made with RCI's POLYLITE polyester resin were responsible for cutting form costs by one-third in this Webb and Knapp apartment project," states Myron Austin, design engineer for Engineered Concrete Form Corporation, Chicago.

Al Schreck, carpenter superintendent for James McHugh Construction Co., Chicago, found these important advantages in reinforced plastic forms:

- They can be adapted to virtually any shape.
- They have greater strength to withstand the impact stresses of cement pours; flexural strength is about 30,000 psi.
- Light in weight, about half that of a lumber form, they can be handled and erected more economically.
- Highly resistant to abrasion, they can be used over and over again.
- Low expansion/contraction properties of reinforced plastic forms, when exposed to heat and cold, provide a high degree of dimensional accuracy in the cured concrete.
- The smooth plastic surface of the forms provide the trowelled-like finish of a skilled concrete artisan, without extra cost.

This is only one example of how plastics are improving on old techniques. If you have an application which might be simplified or improved by the use of reinforced polyester, it will pay you to call on RCI.

Part of the Webb and Knapp apartment project in Chicago which contains 4,500 arched windows poured in POLYLITE plastic forms; and close-up of one of the POLYLITE forms. With proper handling, forms can be used 50 to 100 times.

Webb and Knapp, Developer — I. M. Pei, Architects — James McHugh Construction Company, Concrete Subcontractor — Engineered Concrete Form Corporation, Form Manufacturer

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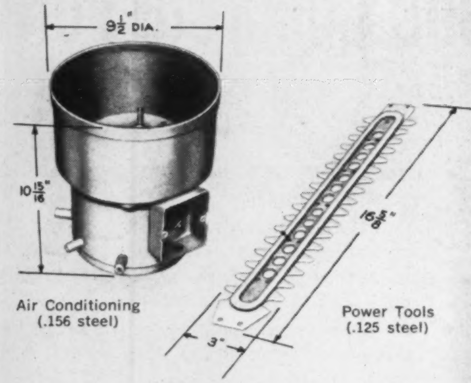
For more Information, turn to Reader Service card, circle No. 431



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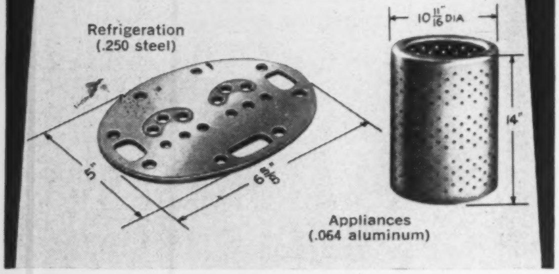

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ROCKWELL-STANDARD CORPORATION
Stamping Division, Utica, New York

For more information, turn to Reader Service card, circle No. 434

M·D·E LETTERS NEW YORK

Letters to the Editor

Publicly available property data

To the Editor:

We are a small manufacturer of gas-fired heating equipment, and have recently developed an infrared, overhead heat fixture for industrial plants. We are using type 430 stainless steel in a thoroughly oxidized surface condition at 1000 F as our emitter.

Some large potential buyers have asked us about the emissivity of type 430 at the conditions described above. We have not been able to get the information from any steel company. However, one company advised that the emissivity of type 430 should be close to that of type 302 stainless steel. It said that an emissivity of 0.78 to 0.80 has been observed for type 302 under the named conditions.

Many of the larger concerns working on infrared have undoubtedly developed this type of information, probably at government expense, and do not release it when asked by smaller concerns such as ourselves.

We think that a table of emissivities and reflectivities of engineering materials at various temperatures would be extremely helpful to small manufacturers in building new and useful equipment.

In our free enterprise system, we sincerely believe that information which is useful to industry should be publicly available . . .

WILLIAM P. HORNE
Bright Leaf Industries, Inc.
Charlotte, N. C.

Properties of gray iron castings

To the Editor:

In the Feb '60 issue of your magazine there appeared an article by R. C. Bates entitled "How Section Size Affects Gray Iron Castings" (p 100). I read the article carefully as I am interested in this field.

I have written a paper which describes a new procedure for predicting mechanical properties of gray iron castings based on chemical composition and thickness of the part.

The procedure is based on the assumption that mechanical properties can be considered to be related by the following factor:

$$K = \frac{4.3 - C}{Si}$$

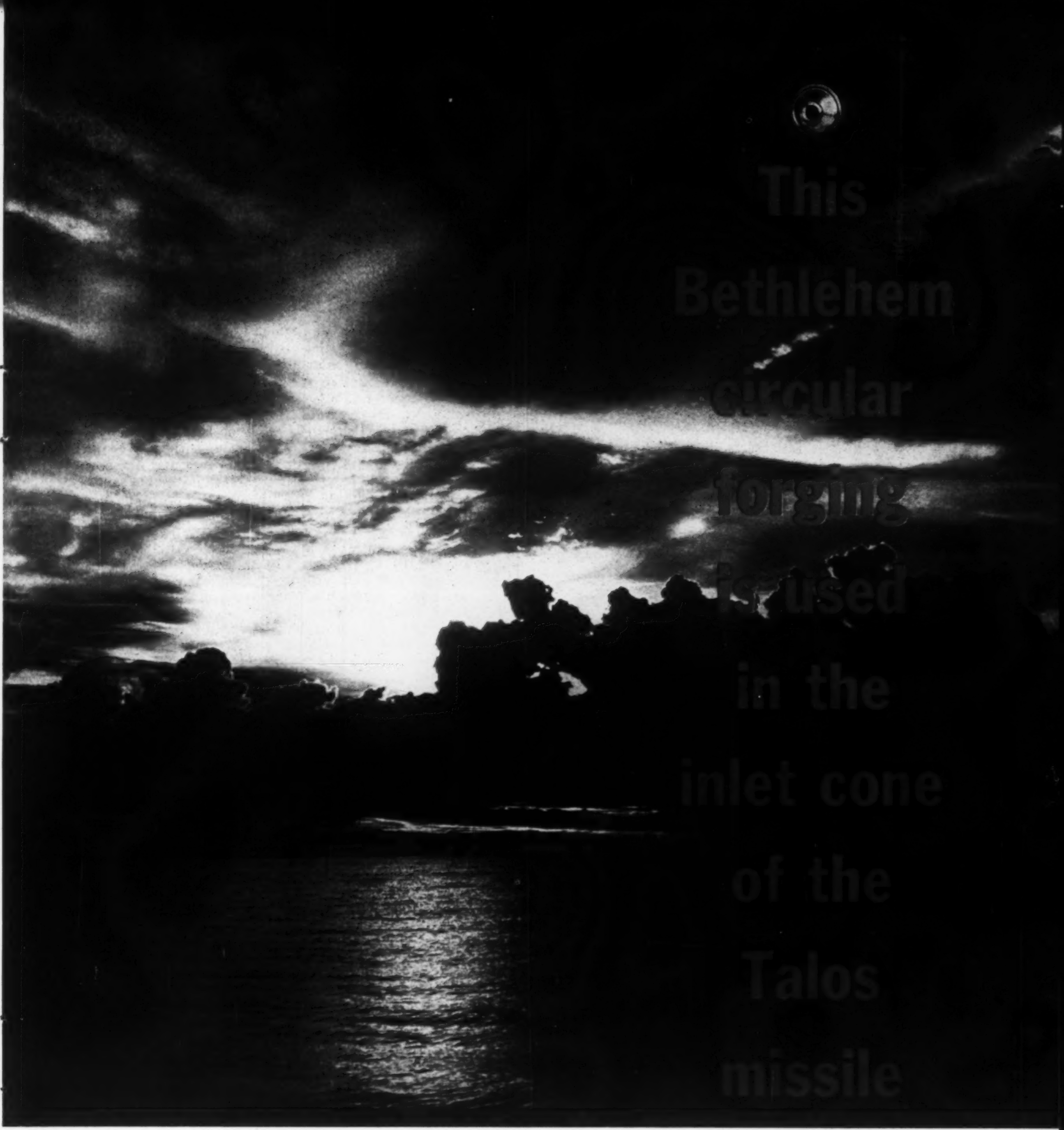
where C and Si are percentages of carbon and silicon, respectively.

Tensile strength is related to thickness of a plate by the following formula:

$$\sigma = \frac{9.1\,(1 + K\sqrt{e})}{\sqrt{e} - K}$$

where σ is tensile strength in kg per sq m and e is thickness of the plate in cm.

Thickness of the plate is related to test bar diameters by a factor that is approximately two but



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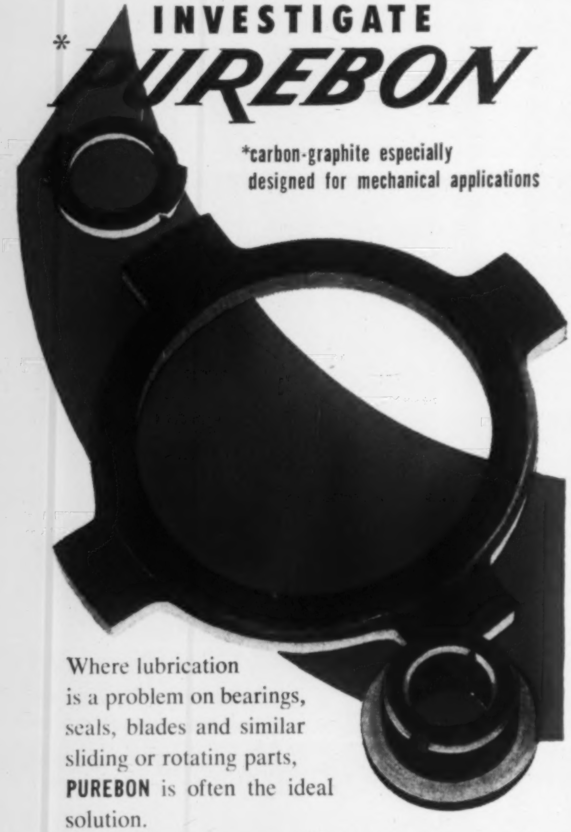

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Letters to the Editor

varies slightly with diameter.

By checking the above formula against various test results, I found good agreement with test bars cast to size and test bars taken from actual parts.

However, I was surprised when I found discrepancies in my formula if values in Fig 3 for Class 30 castings are compared against the formula. I am assuming that the chemical composition given on p 102 for Class 30 castings is an average figure, but differences in composition are quite important for small and large test bar diameters.

My formula checks very well with average test bar diameters, but values are too small for larger diameters and too large for smaller diameters.

Values given in Fig 2 for Class 20 castings check very well with my formula, so I assume that chemical composition does not differ much in this case from the average. Fig 4, 5, 6 and 7 in the article cannot be compared against my formula because they are related to alloyed cast irons which are not taken into account in my formula.

EDUARDO ABRIL
Chief Metallurgist
Industria Kaiser Argentina S. A.
Cordoba, Argentina

A copy of Mr. Abril's letter has been forwarded to author Bates.

High energy rate forming processes

To the Editor:

I have read the very interesting article on "High Energy Rate Forming Processes," and am wondering how I can get further information on powder compacting as mentioned on p 92 of your July issue.

Specifically, I would like to know as much as possible about the studies conducted at China Lake Naval Ordnance Test Station on explosive powder compacting to form neutron absorbers.

JOHN CALDWELL
Research Analyst
Atomics International
Canoga Park, Calif.

Information has been forwarded.

Kudos for filament winding article

To the Editor:

You deserve an accolade from all of us in the filament winding business for the excellent job of assembling and presenting information on filament winding (M/DE, Aug '60, p 127).

F. C. CRYMES
Manager
Commercial Spiralloy Sales
Hercules Powder Co.
Wilmington, Del.

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The company winning the Second Bachner Award Competition will receive the trophy, suitably inscribed, and the individual(s) designated by the company as being most responsible for the achievement will receive $1,000. There is also provision for Honorable Mention Citations. Entries must be received by March 6, 1961. Awards will be made at the time of the National Plastics Exposition in New York in June 1961.

Complete information and entry forms are obtainable from the Secretary to the Committee, Mr. William T. Cruse, c/o Society of the Plastics Industry, Inc., 250 Park Avenue, New York 17, N.Y.

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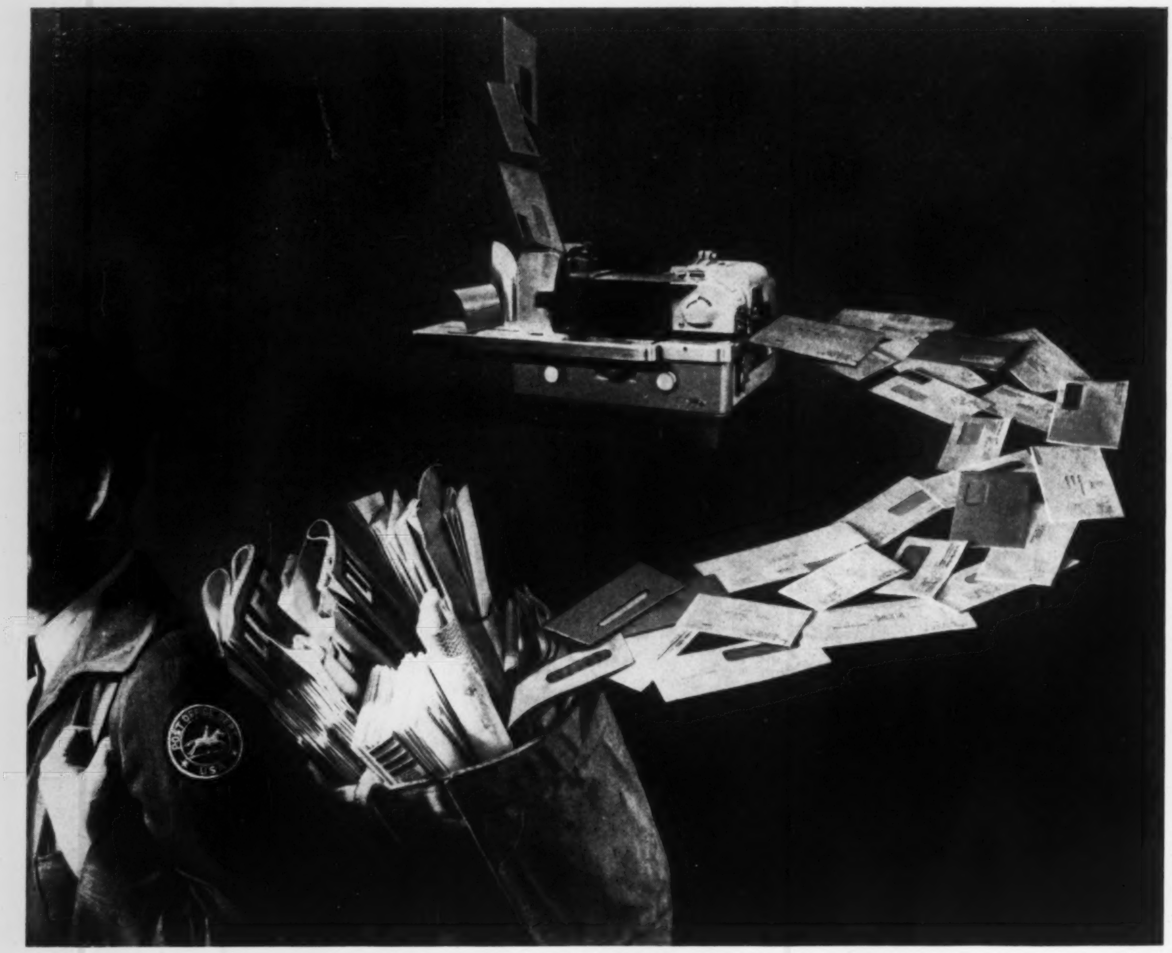

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PRICES & SUPPLY

...AT A GLANCE

Price cuts on stainless steel finished mill products have been announced by Allegheny Ludlum Steel Corp., Crucible Steel Co. of America, Universal Cyclops Steel Corp. and United States Steel Corp. The reductions, applicable to types 304 and 304L, range from 2½ to 3¢ per lb. Products affected by the price cut are sheets, cold rolled strip, bars and structurals, and hot rolled rods, wire and forging billets. In addition, U. S. Steel says it has reduced prices on raw and semifinished types 304 and 304L in ingot and slab form. Plate prices have not been reduced.

Steel imports totaled 1.4 million tons in the first quarter of this year—85% above the 758,000 tons imported during the same period in 1959, says the American Iron and Steel Inst. Despite a decline in domestic steel output, sheet and strip imports soared to 247,000 tons, or 16 times the total for the first quarter of 1959.

Sharp increases in the demand for polycarbonate resins were predicted for the next decade by A. E. Schubert, general manager of GE's Chemical Materials Dept., at the opening of the firm's new polycarbonate plant in Mt. Vernon, Ind. Schubert says the market for polycarbonates should climb to about 30-50 million pounds within five years and reach 75-100 million pounds by 1970. The new GE plant can initially produce more than five million pounds of polycarbonate resins annually.

Price cuts on low density polyethylene resins and compounds have been announced by the major polyethylene producers following an initial price slash by Union Carbide Plastics Co. Basic price for Carbide's low density polyethylene is now 27½¢ per lb in truckload lots, down 5¢ per lb.

Production of polyethylene is being doubled at National Distillers' U.S.I. Div. plant at Houston, Tex. This latest expansion brings U.S.I.'s total production capacity of Petrothene low and medium density resins to 300 million pounds per year.

Price of fused quartz yarn and roving has been cut by General Electric Co. The new prices are $35 per lb for yarn and $29 to $32 per lb for roving. Previous price for the two forms was $65 per lb. Recent tests show that quartz thread and cloth withstand temperatures over 5000 F (M/DE, Feb '59, p 123).

More nickel will be available when International Nickel Co.'s new mining operation at Thompson, Manitoba comes into full scale production in 1961 at an annual rate of 75,000,000 lb. The Thompson project is said to be the second largest nickel-producing operation in the world. At the same time, nickel supplies in this country are said to be more than adequate despite the shutdown of Freeport Nickel Co.'s facilities and the uncertainties surrounding the U. S. government's Nicaro plant in Cuba.

Price of a new high temperature urethane foam system called PAPI (polymethylene polyphenyl-isocyanate) has been reduced to $1.50 per lb in drum lots. Previous price was $2.25 per lb. The material was described in M/DE, July '60, p 11.

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PLASTICS

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News OF INDUSTRY

First Die Casting Show Set for Detroit, Nov 8-11

The first National Die Casting Exposition and Technical Congress has been scheduled for Nov 8-11 at the Detroit Artillery Armory.

The exposition, sponsored by the Society of Die Casting Engineers, is said to be the first show in this country devoted exclusively to the die casting field.

Process widely used

In announcing the new exposition, John C. MacLaren, chairman, pointed out that total die casting metal consumption in 1957 was over 600,000 tons, or more than twice that of 1947.

"It is this explosive growth," he said, that led the Society to sponsor the 1960 exposition.

Exhibitors at the show will include independent and semi-captive die casters, suppliers of die casting equipment, producers of metals and alloys and design services.

Topics based on survey

The Technical Congress, designed to present the latest developments and trends in the die casting field, will also be sponsored by the Society. Subjects have been selected on the basis of an industry survey of specific interests in the die casting field. Topics include: metallurgical developments; die design; die building; what's ahead in die casting; competition to die casting; cost and profit; quality control; vacuum die casting; anodizable die castings; die steels, buffing, polishing and plating of die castings; zinc, magnesium and brass die casting techniques; lubricants; handling and treating of metals; standards; large die castings; and die casting alloys.

For further information, contact the Society of Die Casting Engineers, 19382 James Couzens Hwy., Detroit 23.

Air Force to Study Welding of Refractory Metals

Three new materials research and development programs have been initiated by branches of the armed services.

Two of the contracts, awarded by the Air Force, involve development of 1) improved types of beryllium, and 2) methods of welding molybdenum and tungsten by electron beams. The third contract, awarded by the Navy, is aimed at the development of molybdenum alloy sheet.

Fabricable beryllium

The beryllium project, awarded to Nuclear Materials and Equipment Corp., will concentrate on the development of fabricable beryllium for use in missiles and aircraft. Although beryllium is the lightest metal and has great potential in these applications, it has not as yet been made available with sufficient ductility to be used in significant quantities for these purposes. The objective of the contract is to overcome this problem.

Welding tungsten and molybdenum

Also concerned with missiles and space vehicles will be Hamilton-Standard Div., United Aircraft Corp., which will be studying ways and means of welding tungsten and molybdenum with the electron beam process.

Both molybdenum and tungsten are difficult to weld by normal techniques. Under high welding heats (5000 to 6000 F) they tend to become brittle, and unless heat is confined to the immediate weld area there is a serious loss of the metal's strength.

In the electron beam process, according to Hamilton-Standard, the heat-affected zone can be reduced to an extremely small area—in some cases to a spot less than 0.001 in. in dia.

In its study program, Hamilton-Standard will first produce butt, lap, seam, edge and spot welds in sheets of molybdenum and tungsten ranging in thickness from 0.005 to 0.10 in. It will then study the effects on weld quality of variations in machine settings. And, finally, it will evaluate welded pieces to determine weld quality

METAL SHOW—See pp 47-55 for details on registration, technical program and exhibitors at the 42nd National Metal Congress and Exposition, Oct 17-21, in Philadelphia.

Sunbeam die cast appliance part
North Amer. Philips nylon coil form
Dictaphone die cast circuit connector
Westinghouse insert molded insulating screw
Sylvania nylon TV tuner part
Elec. Autolite die cast instrument gear
Ronson die cast lighter part
Stanley die cast power tool part
Samsonite Intercast hinged luggage closure
GM acetate car radio part
Union Carbide die cast flashlight part
Argus die cast camera part
Yale & Towne die cast lock part
Western Electric Delrin phone dial part
General Electric die cast timer part
Lionel die cast model train part
Remington Rand insert cast sensing brush
Scripto die cast mechanical pencil part
Allen Bradley die cast & molded control parts
IBM insert cast-mold commutator brush
Detecto die cast scale part
Nat'l Cash Reg. nylon adding machine part
Stewart Warner nylon speedometer gear
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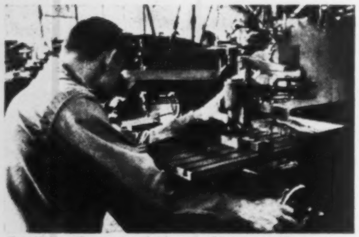

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and microstructure, size of heat-affected zones, ductility of welded areas, and tensile strengths of samples exposed to temperatures as high as 2200 F for molybdenum and 2800 F for tungsten.

Molybdenum alloy sheet

The third project, awarded to Universal-Cyclops Steel Corp., will involve process development in the production of molybdenum alloy sheet. Two alloys will be investigated: molybdenum-0.5% titanium and molybdenum-0.5% titanium-0.07% zirconium.

Specifically, the program is designed to produce optimum conditions of isotropy, homogeneity, and reproducibility. Variables to be studied are: 1) single vs double vacuum arc melting, and 2) the following four methods of processing molybdenum ingot to plate: extrusion of alloys to rounds and then forging them to sheet bar; direct extrusion to sheet bar; extrusion in air with subsequent forging in Universal-Cyclops' In-Fab (inert atmosphere fabrication); and direct forging in In-Fab.

Uses of Magnesium Is Cleveland Topic, Oct 17

"Blueprint for Magnesium" is the theme around which the Magnesium Assn. will hold its 16th annual convention.

Set for Oct 17-19 at the Pick-Carter Hotel, Cleveland, the convention will concentrate on "those applications of magnesium which hold the greatest promise as major potential markets in the next few years."

Technical discussions at the meeting will cover such topics as: thin section, high integrity permanent mold castings by the centrifuge method; magnesium alloys in missiles and satellites; chemical milling of magnesium; successful use and control of emissivity finishes on HK31A magnesium for thermal design; and corrosion protection of magnesium in electronic equipment.

Three other meetings set for October

In addition to the magnesium meeting and the Metals Show (see pp 47-55), three other groups will sponsor meetings on materials and materials problems this month.

Plastics and rubber—The Rubber and Plastics Div. of the American Society of Mechanical Engineers will hold its first annual conference in Erie, Pa. on Oct 9-11.

Papers at the conference will be divided into four basic categories: vibration and shock control; bonding of engineering structures; nonrigid structures; and automation of rubber and plastics processing.

Papers of particular interest include: design strength data and calculation for long-term use of thermoplastics; novel design in sandwich structures; new apparatus for study of mechanical and electrical properties of plastics; and reinforced plastics films.

Space age materials—A one-day symposium on Materials and Processes for Use in the Space Age has been arranged by the Delaware Chapter of the Society of Aerospace Materials and Process Engineers (SAMPE) for Oct 24 at the Bellevue-Stratford Hotel, Philadelphia.

Specific subjects to be covered at the symposium include: a new approach to vacuum bag molding of glass cloth laminates; development and formulation of experimental diisocyanate-based resins for structural laminates; urethane foams for aerospace applications; fluorescent coatings for improved visibility; and application of thick coatings to re-entry vehicles.

Tool seminars—High energy rate forming is the subject of the first of a series of ten technical seminars to be sponsored by the American Society of Tool and Manufacturing Engineers.

The seminar, scheduled for Oct 11-12 at Chicago's Sheraton Towers, will cover design, materials, reliability, forging, extrusion, explosives, hydro-spark, shock waves, and tooling requirements.

Registration fee is $45 for members and $60 for nonmembers.

The series of ten seminars will be held in various industrial areas around the country and will cover standards and standardization, metal cutting, quality control, machining and forming space age materials, plastics tooling, automation and numerical control, die and design, and process planning–operations research.

Additional information can be obtained from ASTME Headquarters, 10700 Puritan Ave., Detroit

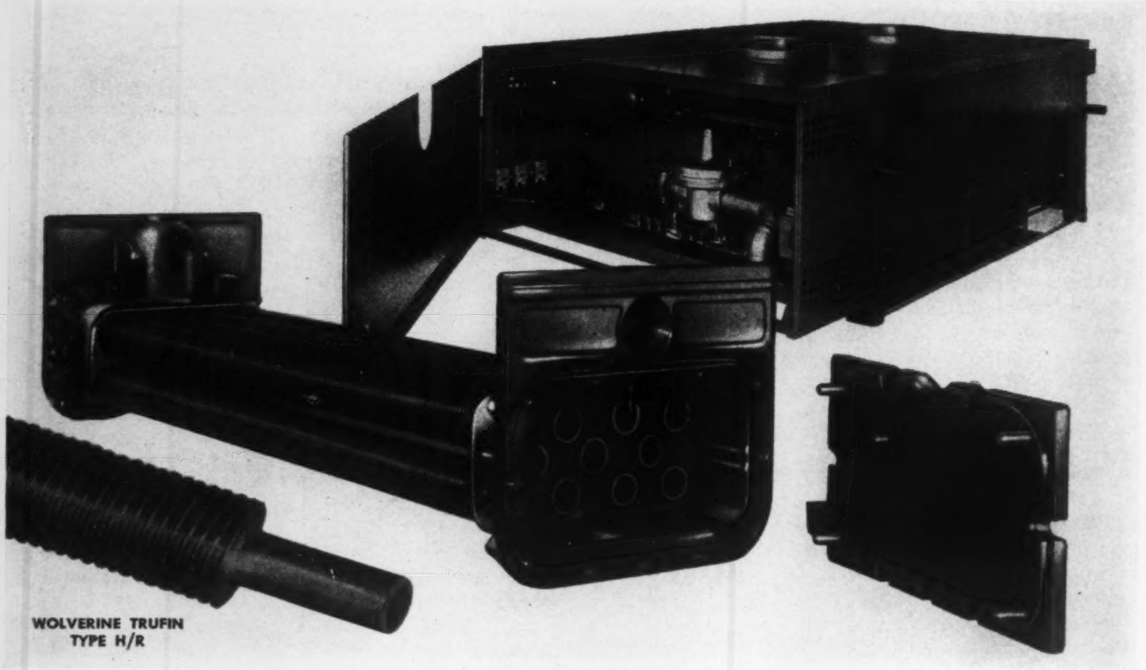
Symposium on Basic Science

A special symposium on Basic Science in France and the United States has been arranged by New York University for Oct 17-19.

The symposium, sponsored by NYU in cooperation with the French Government and supported by a $10,000 grant from the Alfred P. Sloan Foundation, will be held at NYU's Loeb Student Center at Washington Square South. Six French scientists will discuss their fields at general meetings, and six American scientists will join them in panel sessions.

Topics to be discussed include: metal physics, magnetic resonance, hydraulics, astronomy, geology, and science administration.

Coming Meetings on p 31 ⟶



Laars Engineers, Inc. cut pool heater size 291% by tubing with Wolverine Trufin®

Like all manufacturers, designers of equipment for the swimming pool industry want maximum capacity from components of the smallest possible size.

That's why Laars Engineers, Inc., North Hollywood, California, used Wolverine Trufin Type H/R tube when they designed the world's largest capacity swimming pool heater.

Simply by using integrally finned Trufin Type H/R, Laars engineers were able to reduce unit size by a whopping 291%. The heater, with a rating of more than 170 boiler horsepower, has a 7,125,000 BTU input and an output of 5,700,000 BTU's. It is only *195* cubic feet in size. If tubed with bare tube, a unit of similar capacity and horsepower would require approximately *670* cubic feet.

At Laars Engineers, Inc., however, Trufin's amazing ability to pack more heat transfer surface into less space has been well known for a long, long time. Tens of thousands of Trufin-tubed Laars water heaters and boilers are daily giving outstanding performance, both in the United States and throughout the world.

If your company is looking for ways to pack more heat transfer surface into less space, why not let Wolverine Trufin help you increase heat transfer performance. Write—TODAY—for complete information.

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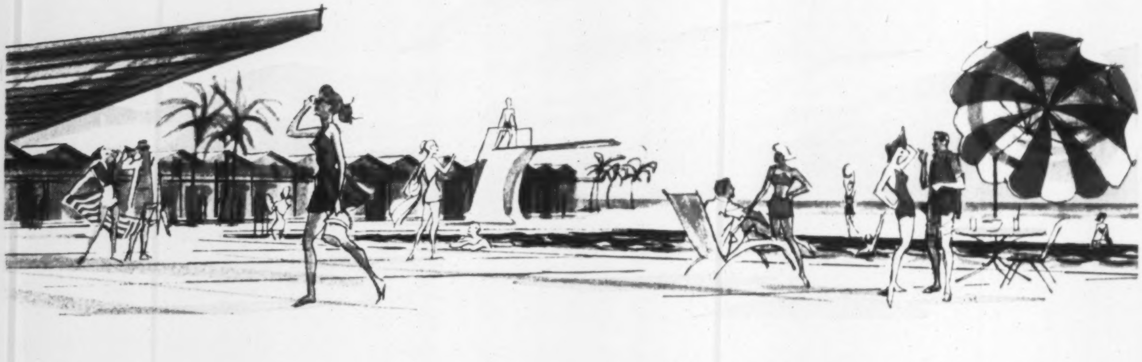


For more information, turn to Reader Service card, circle No. 321

News OF INDUSTRY

Coming Meetings

Pressed Metal Institute, annual meeting. Shawnee-on-the-Delaware, Pa. Oct 10-14.

Gray Iron Founders' Society, Inc., 32nd annual meeting. Cincinnati. Oct 12-14.

Non-Ferrous Founders' Society, annual meeting. Asheville, N. C. Oct 13-15.

Society of the Plastics Industry, Inc., 16th annual New England Section Conference. Portsmouth, N. H. Oct 13-14.

Magnesium Assn., annual convention. Cleveland. Oct 17-18.

15th Plastics-Paper Conference, Technical Assn. of the Pulp and Paper Industry. Syracuse. Oct 17-19.

Society for Nondestructive Testing, annual meeting. Philadelphia. Oct 17-21.

42nd National Metal Exposition and Congress, American Society for Metals. Philadelphia. Oct 17-21.

Metallurgical Society, American Institute of Mining, Metallurgical and Petroleum Engineers, fall meeting. Philadelphia. Oct 17-21.

Society of Plastics Engineers, New York Section Conference. New York City. Oct 19.

National Assn. of Corrosion Engineers, 5th annual north central regional conference. Milwaukee. Oct 19-20.

National Tool and Die Mfrs. Assn., annual meeting. Minneapolis. Oct 19-23.

American Hot Dip Galvanizers Assn., semi-annual meeting. White Sulphur Springs, W. Va. Oct 24-25.

Galvanizers Committee, American Zinc Institute, Inc., 42nd annual meeting. Canton, Ohio. Oct 27-28.

Federation of Societies for Paint Technology, 24th annual meeting. Chicago. Oct 29-Nov 2.

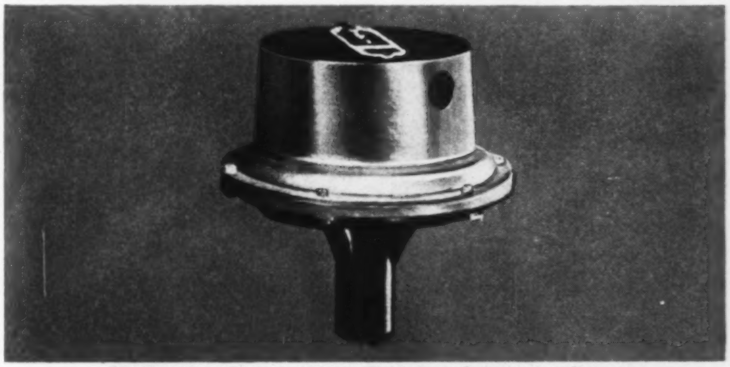
Society of Plastics Engineers, Ontario Section regional conference. Ontario, Canada. Nov. 7.

1st National Die Casting Exposition and Congress, Society of Die Casting Engineers. Detroit. Nov 8-11.

Western Tool Show, American Society of Tool and Mfg. Engineers. Los Angeles. Nov 14-18.

Reevecote broadens use of popular air switch with stronger—more sensitive diaphragms

T. H. Landgraf, Chief Engineer at The Autogas Company of Bellwood, Illinois, says: "The use of a Reevecote diaphragm allows a wider range of control of all kinds of gases, wider temperature range and provides greater strength."



The Shure-Vent Control, product of The Autogas Company, is an increasingly popular air-flow interlocking switch. It is actuated by a strong, sensitive Reevecote diaphragm. Operation is by pressure or vacuum.

Since the heart of this control is its diaphragm, The Autogas Company found the perfect solution in a larger, stronger, more sensitive diaphragm made of Reevecote, a synthetic rubber-coated fabric manufactured by Reeves Brothers, Inc.

If your design calls for a diaphragm — or the use of coated fabrics . . . choose from over 200 styles of Reevecote — the most complete line of coated fabrics for industry.

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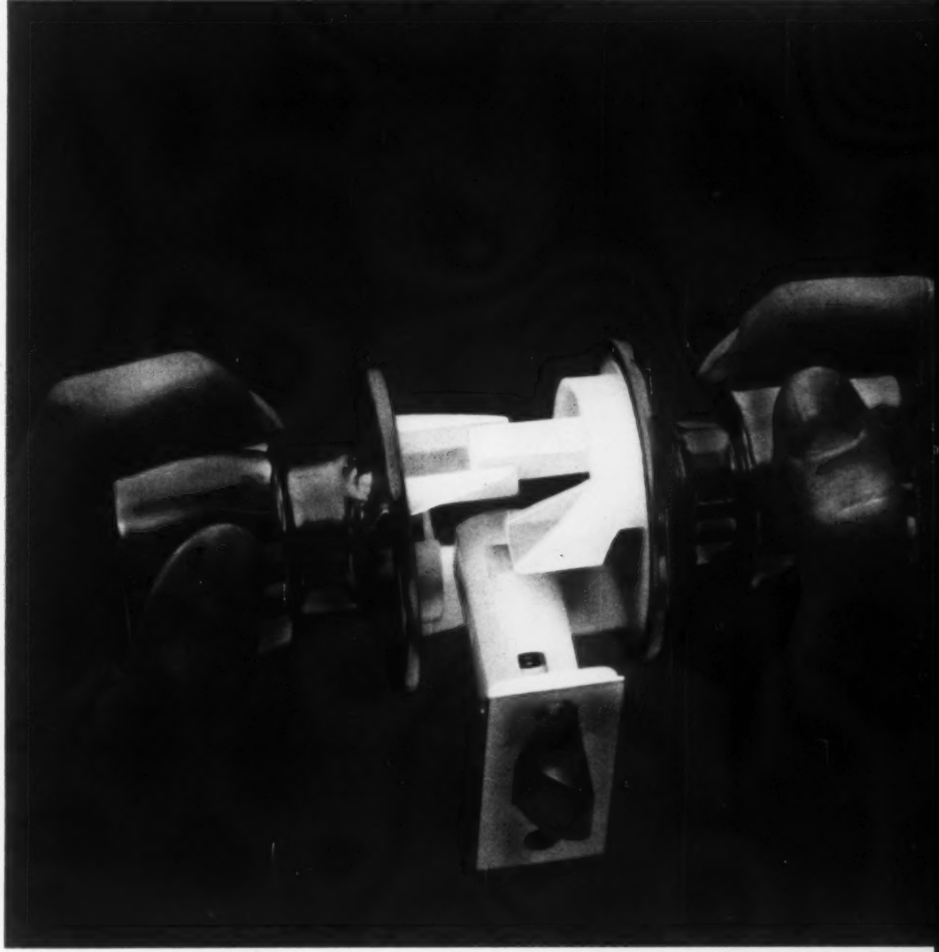

New lockset designed with ZYTEL® offers easy installation...lifetime service...economical production

This is the first plastic lockset ever commercially available—and it took a material with remarkable properties to make it: a material that is exceptionally tough and abrasion-resistant; a material with friction so low as to make lubrication unnecessary; a material that is rust- and corrosion-proof; a material that can be economically molded to close tolerances in large quantities, and one that requires little or no finishing.

In short, it took Du Pont ZYTEL nylon resin.

In this radical design innovation, almost all working parts except the knobs are molded of tough Du Pont ZYTEL. Installation of the lockset is made foolproof; round and square sleeves mate with round and square posts. The entire set is held by two lead-through bolts that drive directly into tap holes in the chassis sleeves. And a self-aligning latch case lets the installer swivel the latch to the right or left of the central lock assembly to compensate for bevel-edged doors or for improper boring. In action, the bolts of ZYTEL were tested up to 1,500,000 cycles—equivalent to more than 100 years of normal household use—before showing any perceptible wear. And the lockset functions smoothly and quietly without lubrication. The Lockwood Hardware Manufacturing Company of Fitchburg, Mass., reports that the parts of ZYTEL are economically mass-produced, need virtually no finishing operations.

On the following page, you will find further illustrations of the design improvements and cost reductions made possible by the complete line of ZYTEL nylon resins.

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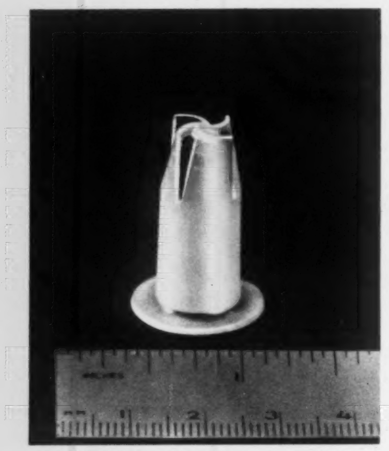
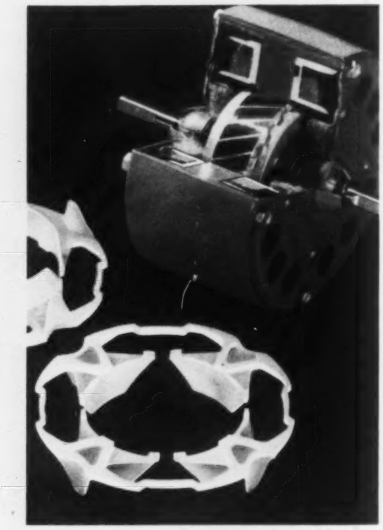


This "anti-gurgle" device is used by a major automobile manufacturer in cooling systems with hot-water heaters, to eliminate air bubbles and noisy heaters. Molded of a special ZYTEL nylon resin specifically designed for hot-water service, it costs only 25% of previously used copper part. (Molded by Kuhlman Plastics, Kansas City, Mo.)



Complex end-turn insulator molded of ZYTEL is used to simplify assembly and improve performance of fractional-horsepower motors. ZYTEL provides the necessary molding characteristics, good electrical properties, heat resistance and high strength in thin sections. (Molded by Carpart Plastics, Inc., for Redmond Co., Inc., both of Owosso, Mich.)

Feeding-finger pads for screw-machine stock are economically molded of tough, abrasion-resistant and resilient ZYTEL. According to the manufacturer, they are the best pads yet developed for feeding soft materials . . . and for centerless stock, where freedom from marking is important. (By T and M Engineering, Inc., of Valparaiso, Indiana, for Brown & Sharpe Mfg. Co. of Providence, R. I.)

Doing it better at lower cost:

3 more examples of ZYTEL® in action

The versatility of ZYTEL nylon resins stems directly from an unusual union of mechanical, chemical, electrical and processing properties. Some combination of these properties may well provide a solution to a design problem of yours. Find out more about the performance and cost advantages made possible by ZYTEL—simply fill out and mail the coupon below.

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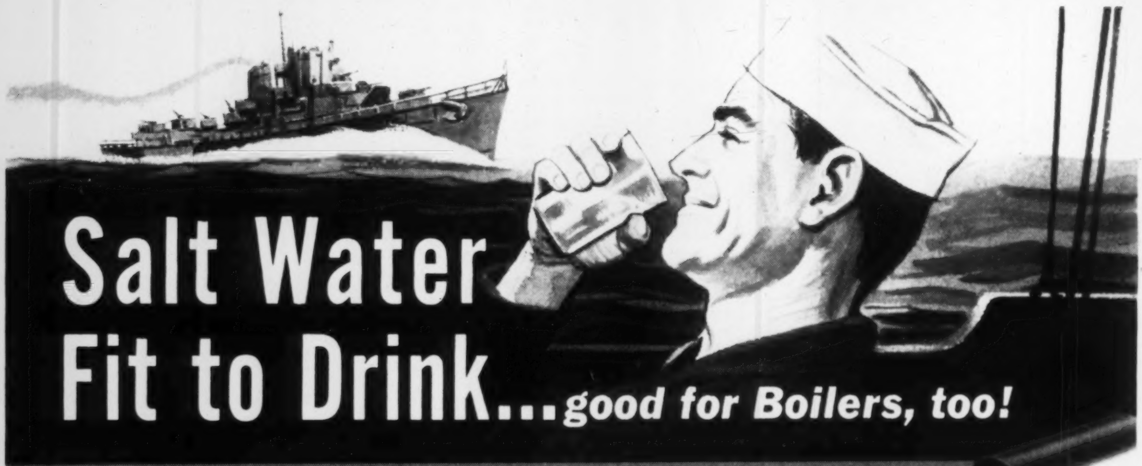
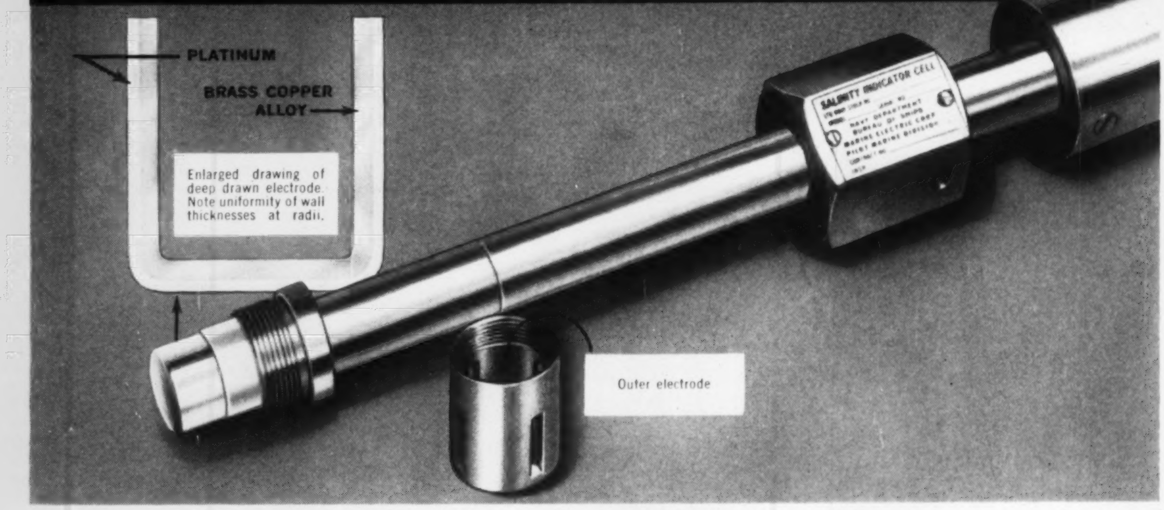


Salt Water Fit to Drink...good for Boilers, too!



Enlarged drawing of deep drawn electrode. Note uniformity of wall thicknesses at radii.

General Plate Platinum Clad Electrodes Help Conductivity Cell Measure Water Impurities

Assure Constant Performance ...Reduce Costs

The operating principle of the Pilot Marine Salinity Indicating System is based upon the measurement of the electrical conductivity of water which is determined by salinity and temperature.

Materials originally used as electrodes in the cell did not meet performance requirements. For instance, . . . silver, tin, nickel and palladium corroded or were consumed too rapidly . . . in platinum electroplated electrodes, the platinum wore off too rapidly, and the other metals had a tendency to polarize, skewing indicator panel readings . . . solid platinum sleeve, inserted in a casing of base metal and outer layer drawn to size of platinum sleeve, collapsed under high temperature and pressure.

Pilot Marine Engineers turned to the General Plate Products group of Metals & Controls division for a solution to the problems involved in electrodes used on the conductivity cell.

General Plate Platinum clad P-20 (brass-copper alloy) drawn into a cup shape and matching piece in the form of tubing, as fabricated by General Plate, met all the performance requirements . . . reduced costs, too.

General Plate Platinum-Group Clad Metals, and fabrication facilities offer users greater savings in present applications, as well as new uses. Typical uses include linings for vessels, electrical contacts, rupture discs, electrodes, anodes and laboratory ware. Bulletin PLA-1 gives full details. Write for your copy.

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Suppliers' New Bulletins

Hardenable Cast Stainless Alloy. Alloy Casting Institute, 6 pp, illus. Composition, room temperature properties, corrosion resistance, weldability, typical applications and other information on a hardenable cast stainless steel alloy. **1**

Shaped Wire Catalog. Page Steel & Wire Div., American Chain & Cable Co., Inc., 16 pp, illus., No. DH-1226-A. Information on various analyses of wire preshaped to a desired cross-section. Included is information on methods of calculating areas of common shapes; physical properties of steel wire; a table of standard wire gages; and hardness conversion tables. **2**

Custom Plastics Extrusion. Anchor Plastics Co., Inc., 72 pp, illus., No. AP60-RM. Several articles cover the design and application of plastics extrusion, including information on the facilities available from this company. Also covered are property tables, short descriptions of materials, and more than 700 cross-sectional diagrams of typical plastics extrusions. **3**

Nickel-Plated Steel. Apollo Metal Works, 8 pp, illus. Information on the fabricating characteristics of nickel-plated steel. **4**

Porous Bronze, Iron Bearings. Bound Brook Oil-Less Bearing Co., 36 pp, illus. Comprehensive list of sizes and types of porous bronze and porous iron bearings and washers. **5**

Integrally Finned Tubing. Wolverine Tube Div., Calumet & Hecla, Inc., 4 pp, illus. General description, sizes and materials available, and typical uses of integrally finned tubing. **6**

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Castable Ceramic Fiber. Carborundum Co., Research & Development Div., 3 pp. Properties, casting procedures, prices, and suggested uses of a castable ceramic fiber. **8**

Stainless Steel Services. G. O. Carlson, Inc., 12 pp, illus. Information on stainless steel plates, heads, forgings, rings, circles, flanges, bars, and sheets used in the metalworking, chemical process, nuclear, and aircraft and missile industries. **9**

High Density Polyethylene. Celanese Polymer Co. Div., Celanese Corp. of America, 10 pp, illus., No. P2A. Series of typical applications show the advantages of high density polyethylene for such things as toys and sporting goods, housewares, bottles, containers and closures, textile applications, industrial applications and film. **10**

Vinyl Plastisols. Chemical Products Corp., 12 pp, illus., No. 144. Chemical and physical characteristics, advantages, and typical uses of vinyl plastisols applied by dipping, casting, low pressure forming, wiping, spraying, and spreader coating. **11**

Stainless Steel Tubing. Columbia Steel & Shafting Co., Summerill Stainless Tube Div., 4 pp, illus., No. 7247. Analyses, tolerances, specifications, sizes and other information on a line of stainless steel tubing. **12**

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Universal Testing Machine. Budd Co., Instruments Div., 4 pp, illus., No. BM-2090. Specifications, characteristics, advantages, and other information on a testing machine designed to perform tension, compression and flexure tests. 170

Processing X-Ray Films. Eastman Kodak Co., X-Ray Div., 6 pp, illus. Describes an entirely new system of faster, better processing for industrial X-ray film. 172

High Temperature Furnace. Pereny Equipment Co., Inc., 2 pp. Specifications, advantages, and other information on a high temperature furnace for uses calling for long periods of sustained high temperature. 174

Vacuum Impregnating Systems. F. J. Stokes Corp., 12 pp, illus., No. 652. General information, advantages, characteristics, specifications, typical applications and other information on a line of vacuum impregnating systems. 178

To get suppliers' free literature use prepaid post card on pp 37 and 38.

ECONOMY, DURABILITY AND DEPENDABILITY are outstanding characteristics of these sintered metal gears. Parts like these are the result of close cooperation between Delco Moraine and its customers from idea through design and development to production.

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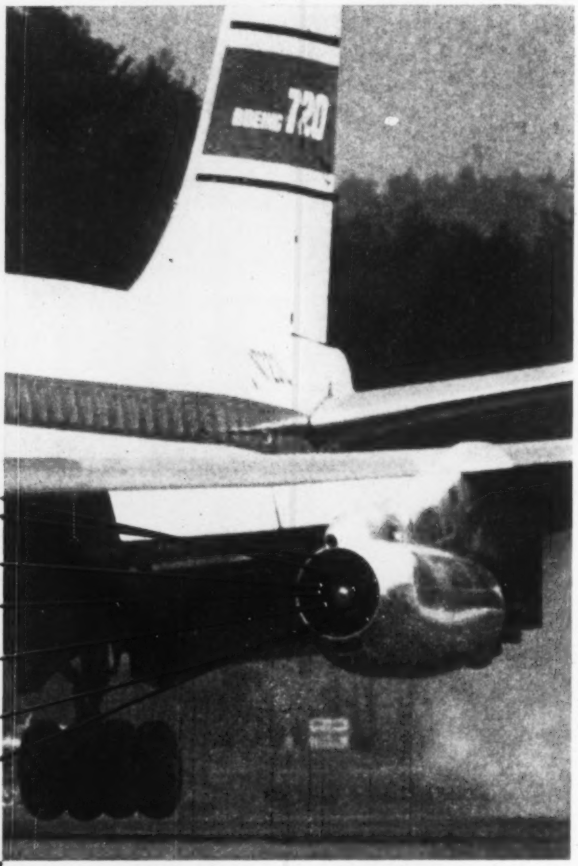

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Thrust reverser bearing assemblies, made of Latrobe's Vac-Arc BG 41 Stainless, take compressive stresses of more than 600,000 psi and temperatures in excess of 800°F. as new Boeing 720 jetliner brakes to a stop. Bearings by Torrington Co.; Thrust Reversers by Rohr Aircraft; Jet Engines by Pratt & Whitney Aircraft.

VAC-ARC BG 41 "hot hardness" withstands critical braking action of new Boeing 720

Through the use of thrust reversers and wheel brakes, the new Boeing 720 has been brought to a full stop within 2200 feet after runway touchdown—bringing high speed jet service to restricted runway facilities throughout the world.

The thrust reverser bearing assemblies, made of Latrobe's new Vac-Arc BG 41 Stainless (modified Type 440 C), withstand the critical stresses at elevated temperatures imposed by the braking action of reversing the jet engine thrust.

Here's another example of Latrobe Metalmasters meeting the challenge for super steels in the jet and missile age. Vac-Arc Steels (consumable electrode vacuum melted) continue to set new standards for cleanliness, homogeneity and high strength.

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For more information, turn to Reader Service card, circle No. 396

PREVIEW

1960 Metal Show

42nd National Metal Exposition and Congress, Oct 17-21

The Exhibits

Approximately 25,000 people are expected to visit some 300 separate exhibits at Philadelphia's Trade and Convention Center during the 42nd National Metal Exposition. The theme of this year's show is "A Competitive America through Improved Technology."

According to Allan Ray Putnam, ASM managing director, this year's Show will provide ". . . the greatest concentration of technical exhibits on metals, forms and shapes, and processes in the 42-year history of the ASM Metal Shows."

A new and unique feature of the Show will be the Steel Arena—a special area containing exhibits prepared by 16 of the country's major steel companies. Theme of the Arena is "Build It Better with America's Steel—Basic Material of Construction." Purpose of the Arena is to dramatize, with hundreds of samples of steel products, the latest advances in metalworking technology. In addition, some 200 experts in every phase of steel—engineering, metallurgy, production, and marketing—will staff the arena exhibits to provide a "reservoir of technical information unique in an industrial exposition." These consultants will answer all questions.

Another unique feature of this year's show is the strict control over individual exhibits. According to ASM, extensive personal interviews were conducted to determine the type of exhibits that previous registrants felt would be most helpful. As a result of these interviews, 11 product categories were established as the basis of acceptance for exhibitors. All exhibits at the Show, therefore, will be concerned with one or more of the following: ferrous metals; nonferrous metals; related engineering materials; nuclear materials and equipment; tool materials; industrial heating equipment and supplies; cleaning and finishing equipment and supplies; welding and joining equipment and supplies; testing, inspection and control equipment and supplies; metal production and casting equipment and supplies; and parts, forms and shapes for design and application.

Exposition hours are from 10 a.m. to 6 p.m. on Monday, Thursday and Friday, Oct 17, 20 and 21; and from noon to 10 p.m. on Tuesday and Wednesday, Oct 18 and 19. A complete list of exhibitors and their booth numbers is given on pp 53 and 55. Visitors will be especially welcome at M/DE's booth, 1256.

The Technical Program

This year, as last, the National Metal Congress will be sponsored by the American Society for Metals in cooperation with the Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers; Society for Non-Destructive Testing; Industrial Heating Equipment Assn.; Metal Treating Institute; Ultrasonics Mfg. Assn.; Special Libraries Assn.; and Metal Powder Industries Federation.

In addition to the many technical programs offered by these societies, the following special events have been planned: 1) an ASM seminar on "Strengthening Mechanisms in Solids"; 2) an ASM-AEC seminar on "Non-Oxide Nuclear Fuels"; 3) a special "Symposium for Steel Users"; and 4) ASM's Metals Engineering Program Committee Conference (Woodside Memorial Panel).

A condensed program covering technical sessions of ASM, AIME, SNDT and MEPC appears on p 49. Complete sessions of particular interest to engineers and designers engaged in materials selection and use are listed on page 51. Listed at right are the programs of the other cooperating societies:

Tuesday, Oct 18, Industrial Heating Equipment Assn. will present five papers on heat treating of stainless steels: Atmospheres and Furnaces, Brazing, Vacuum Furnaces, Flat Products, and Tube and Wire.

Wednesday, Oct 19, Metal Powder Industries Federation will present four papers: Sintered Brass, Ceramic Molds, Thin Walled Cones, and Iron Powder by the Fluidized Bed Method.

Thursday, Oct 20, Metal Treating Institute will present two papers on heat treating components for space age products: Vacuum Heat Treating, and Heat Treating Specifications.

Thursday, Oct 20, Ultrasonics Mfg. Assn. will present four papers on ultrasonics: Dissimilar Metal Joining by Ultrasonics, Developments in Ultrasonic Equipment, New Applications, and Cleaning Shot Blasted Strip.

Thursday, Oct 20, Special Libraries Assn. will present three papers on joining metals: Fundamentals of Inert-Gas Shielded Consumable Electrode Process, Inert Gas Tungsten Welding in Aircraft and Missiles, and Silver Brazing.

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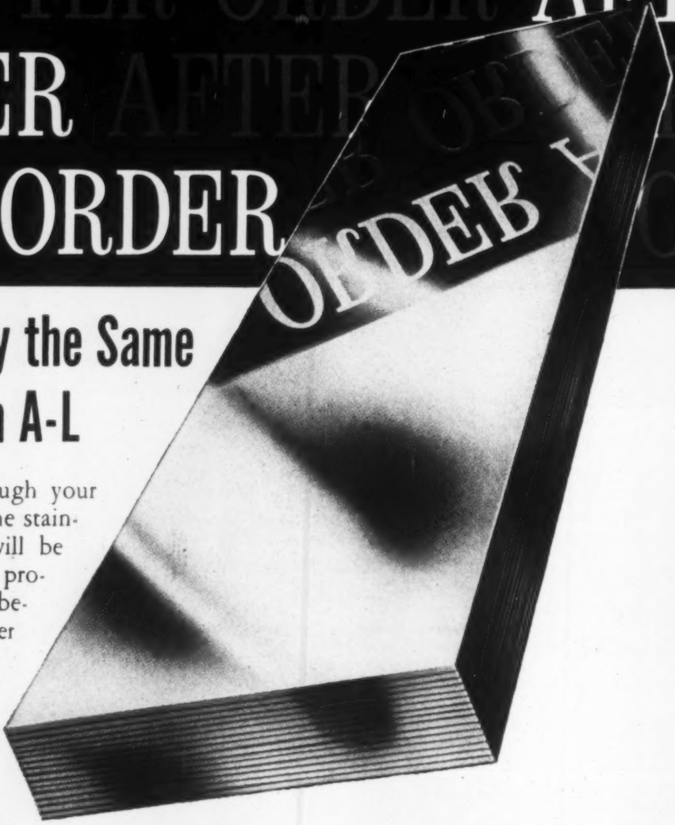

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1719

For more information, turn to Reader Service card, circle No. 320

Condensed Program of Technical Sessions[a]

42nd National Metal Congress and Exposition

Society ➡	AMERICAN SOCIETY FOR METALS Bellevue-Stratford	ASM METALS ENGINEERING CONFERENCE Bellevue-Stratford	AMERICAN INSTITUTE OF MINING, METALLURGICAL AND PETROLEUM ENGINEERS Sheraton	SOCIETY FOR NONDESTRUCTIVE TESTING[b] Benjamin Franklin
Mon, Oct 17 Morning	• Physical Metallurgy	• Materials for the Aerospace Age—**12**	• Thermodynamics (abstracts) • Advances in Stainless Steel Metallurgy—**11** • Diffusion	• Inspection of Steel
Afternoon	• Physical Metallurgy	• Metal Joining	• Ingot Structure Control • Imperfections (abstracts) • Advances in Stainless Steel Metallurgy—**4** • Ingot Structure Control • Metallurgy in the Army—Requirements, Applications and Research	• General Testing—**10**
Tues, Oct 18 Morning	• Phase Diagrams • Steel	• Failure Analysis	• Titanium (abstracts) • Process Simulation • Phase Transformation (abstracts) • Effect of Extremely High Pressures—**5**	• Testing and Quality Control
Afternoon	• Steel • Plastic Deformation	• Failure Analysis	• Titanium vs Steel and Aluminum in Pressure Vessels • Effect of Extremely High Pressures (abstracts) • Hot Extrusion • Physical Chemistry	
Wed, Oct 19 Morning			• Metallic Moderators and Claddings Materials • Gases in Metals (abstracts) • Austenite Decomposition • Physical and Magnetic Properties (abstracts)	• Electronics • Power and Nuclear Plants
Afternoon	• Steel—**7** • High Temperature Materials—**1**	• Recent Advances in Metallurgical Microscopy	• Refractory Alloy Sheet • Metallic Moderators and Cladding Materials • Structural Materials in Cryogenic Design—**9** • Austenite Decomposition • Plastic Deformation (abstracts)	• Applications of Testing in Electronics • Gas Transmission Plants and Piping
Thurs, Oct 20 Morning	• Nuclear Materials	• Effects of Structure on Properties—**8**	• Plastic Deformation (abstracts) • Refractory Metals • Powder Metallurgy (abstracts) • Engineering Fundamentals of Rolling Process	• General Testing—**6**
Afternoon	• Embrittlement—**2**	• Effects of Structure on Properties—**3**	• Refractory Metals (abstracts) • Creep, Fatigue and Fracture (abstracts) • Powder Metallurgy (abstracts)	• Quality Assurance in the Field

[a] More details on numbered sessions appear on p 51.

[b] Friday, Oct 21: educational clinics morning and afternoon.

RB&W FASTENER BRIEFS

MAKING THE MOST OF MODERN MECHANICAL FASTENING

Technical-ities

By Fred E. Graves

No difference between hex and cap screws

It's not the *name* of a standard fastener that determines whether to use it for a particular application, but vice versa. The *application* requirements for strength and tolerances dictate the fastener.

Thus, if you have a joint that calls for certain tolerances in a screw, obviously the one which satisfies those tolerances is the right fastener.

IDENTICAL STANDARDS

In the case of cap screws and hex screws, the standards will show you that these are merely different names for the same product. They're actually made on the same machines, to identical tolerances, and from identical materials.

No reason then to differentiate. For tapped holes, merely specify Hex Screws (SAE Grade 2) or High Strength Hex Screws (SAE Grade 5), and you'll get the *right* fastener with the quality needed.

For bolted joints, these same items are supplied with nuts when specified.

This should suggest a way you can extend standardization in your plant . . . and benefit from our new simplification of nomenclature which calls *any* fastener with head on one end and threads on the other a *screw;* and a screw plus nut a *bolt.*

See how "holding power" can cut fastener costs

SIZE	SAE GRADE	SAE PROOF LOAD	COST RATIO
¾"	Gr. 5	28,400 lbs.	100%
1"	Gr. 2	16,950 lbs.	188%
1⅛"	Gr. 2	21,350 lbs.	239%
1¼"	Gr. 2	27,100 lbs.	277%

Since the usual job of a threaded fastener is to hold an assembly tightly together, its *clamping force* is what you're really utilizing. This seems obvious. But how best to get the clamping force needed for the joint design? Not so obvious. Looking at size alone can be misleading . . . *and quite costly,* as the chart above demonstrates.

HOLDING POWER MEANS MORE THAN SIZE

SAE "proof load" of four different hex screws of standard steels, along with typical cost ratios, are compared. Almost unbelievable, isn't it? Yet it's a fact that the smallest of the group—the heat treated SAE Grade 5 *RB&W High Strength Hex Screw* exceeds all the others in load capacity. It can be used in place of any of the others in most normal usages.

Since it's smallest and therefore weighs the least, it also costs less... 64% less than the 1¼-inch grade 2 hex screw; 58% less than the 1⅛-inch; 46% less than the 1-inch. And since holes can be made smaller, there are also the savings in production drilling . . . and possibly in materials, too.

DESIGN ADVANTAGE

Remember, too, that smaller fasteners are more easily torqued to higher preload levels . . . which helps keep joints tight, makes them more vibration-proof.

If you would like to explore this approach to fastener economy and better utilization of "holding power," consult with an RB&W specialist. Let him contribute his fastener knowledge to your design and production needs. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. **Additional sales offices at:** Ardmore (Phila.), Pa., Pittsburgh; Detroit; Chicago; Dallas; San Francisco.

For more information, turn to Reader Service card, circle No. 385

12 Materials Sessions of Special Interest[a]

42nd National Metal Congress and Exposition

1. High Temperature Materials

- Constitution of Re-Cb Alloys
- Beta Transformation of Titanium Alloyed with Vanadium and Aluminum
- Mechanical Properties of Tantalum Alloys
- Nickel Alloys for Advanced Temperature Applications
- High Strength Martensitic Steels for Elevated Temperatures
- Alloying to Improve Ductility of Vanadium Structure and Mechanical Properties of U-Ti Martensitics
- Effect of Alloy Additions on Properties of Uranium

2. Embrittlement

- Temperature and Microstructure Dependence of Size Effects in Notched Bend Tests of Some Alloy Steels
- Embrittlement of High Purity Nickel
- Influence of Hot Rolling on Brittle Fracture in Steel Plate
- Effect of Induction Tempering on 500 F Embrittlement
- Occlusion of Hydrogen by Annealed Hypoeutectoid Iron-Carbon Alloys
- Hydrogen Embrittlement in Vanadium-Columbium Alloys

3. Effects of Structure on Properties

- Effect of Composition, Structure and Processing on Properties and Application of Iron-Nickel Alloys
- Effect of Structure on Properties of Gray and Ductile Irons
- APM Alloys
- Refinement of Primary Silicon and Eutectic in 21% Silicon-Aluminum Alloy
- Effect of Elevated Temperature on Strength and Microstructure of René 41 Microstructure vs. Properties of Titanium Alloys

4. Stainless Steel Metallurgy

- Composition vs Stress-Corrosion Cracking
- Sub-Zero Rolling of Stainless Steel
- Temperature Dependent Fatigue in Austenitic Stainless
- Effect of Delta Ferrite on Hot Cracking

5. Effect of Extremely High Pressures

- Static Pressure Research in Metallurgy
- Phase Transitions of Pure Metals at High Pressures
- Shock Waves in High Pressure Studies

6. General Testing

- Photostress
- Automatic Magnetic Particle Inspection
- Experimental Stress Analysis
- Density Ratio Method—Radiographs

7. Steel

- Corrosion of Stabilized Stainless Welds
- Metal Wear by Scoring
- Mechanism of Intergranular Oxidation of 18 Cr-8 Ni Stainless (1100-1400 F)
- Hardenability Effect of Boron in Steel
- Determination of Hardness in Steels from Breadth of X-Ray Diffraction Lines

8. Effects of Structure on Properties

- Microstructure vs Notch Toughness of Hardened Steel
- Fracture Toughness and Structure of Steels for Pressure Vessels
- Heat Treatment Variables vs Fracture Characteristics of Steel
- Structural Effects of Strengthening Low Alloy Steels by Deforming Austenite
- Influence of Microstructure on Corrosion Resistance

9. Structural Materials in Cryogenic Design

- Design Criteria for Cryogenic Tanks
- Design Criteria for Airborne Tanks
- Cryogenic Structural Materials
- Aerospace Materials at Low Temperatures
- Temperature vs Fracture Testing of High Strength Sheet
- Evaluating Relative Notch-Sensitivity of High-Strength Sheet

10. General Testing

- Submarine Steel Weldments
- Electron Spin Resonance Spectroscopy
- Three Dimensional Presentation of Flaws
- Bonded Laminates

11. Stainless Steel Metallurgy

- Hardening in 17-7 PH Stainless
- Influence of Carbides on Transformation of Semiaustenitic Stainless
- Carbides in Austenitic and PH Stainless
- Submicroscopic Structures in Tempering 410 Stainless
- Creep-Rupture

12. Materials for the Aerospace Age

- Properties of Materials for Aerospace Environment
- Fabrication Techniques for Aerospace Systems
- Selection of Materials for Aerospace Systems

---

[a] Dates, times and meeting places of these sessions are indicated on p 49.

THESE ARE EXTRAORDINARY FLUXES

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1200 UNIVERSAL FLUX
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The correct selection of flux can offer unexpected help in speeding and simplifying production, minimizing rejects and lowering costs in low temperature silver brazing operations. The advantages to be gained by "selective fluxing" are *sufficiently important to warrant careful, thorough study!*

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Call the Silvaloy distributor in your area for consultation and detailed information or, send for our booklet "A Complete Guide to Selective Fluxing for Low Temperature Silver Brazing."

Silvaloy fluxes are packaged in 65-lb. and 30-lb. drums, 5-lb. wide mouth jars (5 to a carton), 1-lb. and ½-lb. jars. The wide opening of the 5-lb. package makes it a most practical, time saving dispenser that also enables the operator to make use of every bit of flux in the jar.

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A COMPLETE GUIDE TO SELECTIVE FLUXING FOR LOW TEMPERATURE SILVER BRAZING...
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Exhibitors — 1960 Metal Show

Figures indicate booth numbers

Aerobraze Corp.	1274
Ajax Electric Co.	717
Ajax Magnethermic Corp.	1810
Al-Fin Corp.	1855
Allegheny Ludlum Steel Corp.	114
Allison-Campbell Div., American Chain & Cable Co., Inc.	1466
Alloy Steel Casting Co.	1470
Aluminum Co. of America	1410
American Brake Shoe Co.	841
American Cast Iron Pipe Co.	1220
American Cystoscope Makers, Inc.	1854
American Gas Assn.	1910
American Machine & Metals, Inc., Riehle Testing Machines Div.	1909
American Metal Market	1262
American Optical Co.	805
American Pullmax Co., Inc.	1756
American Society for Metals.	250
ASM Automotive Exhibit	1310
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Dow Chemical Co.	1519
Wilbur B. Driver Co.	1567
Dry Clime Lamp Corp.	1571

E. I. du Pont de Nemours & Co.	1405
Eastman Kodak Co.	1727
Eclipse Air Brush Co.	1702
Edmund Scientific Co.	1771
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Electric Hot Pack Co., Inc.	1250
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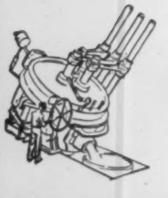
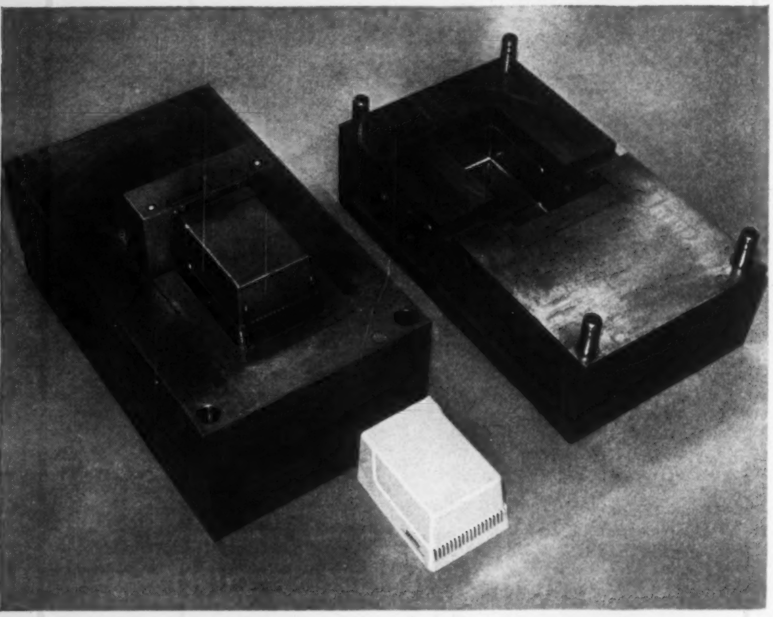


Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation



LUSTRE-DIE does smooth job in molding can-opener housing

Bethlehem Lustre-Die tool steel, which is furnished pre-heat-treated in bars, recently turned out a top-quality molding of high-impact polystyrene at Cepco Plastics Co., St. Louis. The plastic-injection mold, made by Lambert Engineering Co., produced a sturdy, attractive can-opener housing for Swing-A-Way Manufacturing Company.

Here are the reasons why Lustre-Die made such a hit: 1. It saved time, because no heat-treatment was required. 2. It was easier to machine than other pre-hardened grades which were previously used. 3. It polished beautifully, and imparted a high sheen to the finished part.

An electric-furnace steel with a well-balanced basic analysis, Lustre-Die is ideal for working with plastic because it takes a glossy polish. This tool steel also has something extra: a special alloy fortification which further increases its depth of hardenability and enhances its mechanical properties. It is heat-treated by oil-quenching and tempering at the mill, and is furnished ready for machining and polishing. Careful manufacture and quality control insure its freedom from porosity.

You can take our word for it—Lustre-Die is just what you need for a good plastic-molding job. For full details, and prompt delivery, get in touch with your Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Straighten tools while they are hot

Though seldom recognized or appreciated, straightening is an essential part of the quench and temper hardening operation on long, slender tools. The correction of warpage which occurs either in heating tools to the quenching temperature, or from stresses generated in the quench, must be done during heat-treatment. Only minor straightening can be done on hardened tools at room temperature after the hardening operation is complete.

For example, the major straightening on a long rectangular shear blade must be done during quenching. The heat-treater learns by experience at what point the quench can be interrupted so that straightening can be performed. This point varies with the grade of tool steel, and the size and shape of the shear blade. Straightening usually is performed by bending the tool slightly on a press (so-called gag straightening).

Small amounts of additional straightening can be accomplished when the tool is at the tempering temperature. Or, if necessary, this can be done by reheating to a point just below the final tempering temperature.

Minor mechanical adjustments in the final assembly of tools and components are often made by peening the concave surfaces with a hand hammer. This should be done cautiously to avoid spalling or cracking. However, it is preferable to straightening by cold-bending.

New Booklet on Oil- and Air-Hardening Grades

We have a new illustrated booklet on oil- and air-hardening tool steels. It presents essential data about the BTR, Air-4, Lehigh H, and A-H5 grades. For your copy, write to Publications Dept., Bethlehem Steel Co., Bethlehem, Pa. Ask for Booklet No. 532.

BETHLEHEM OIL- and AIR-HARDENING TOOL STEEL

For more information, turn to Reader Service card, circle No. 337

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KSM Products, Inc.	1716
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Kester Solder Co.	1954
King Tester Corp.	832
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Wyandotte Chemicals Corp.	1722

DOW

NEWS ABOUT PRODUCT DESIGN AND MATERIALS

Rare indeed is the design that cannot benefit from the application of today's plastics materials. From the ultra-high performance standards required by America's weapons program, to the equally high standards demanded by America's army of consumers, plastics are meeting the toughest tests head-on . . . and passing them with flying colors. For example . . .

HOW MODERN PLASTICS HELP MAKE MISSILES GO... BUSINESS FLOW

One of the most challenging problems today's design engineer has is the development of missile components that will stand up under severe firing conditions. In many cases, designers are meeting this challenge with the help of modern plastics materials. Here, for example, is how a Dow thermosetting resin helps keep the Minuteman Missile at readiness for instant firing.

Producing relays for the ground checkout system of one of America's new missiles, a major electronic component manufacturer had to meet rigid design and performance requirements.

Their relay, a micro-miniature plug-in unit, was designed to be potted in an epoxy compound to give the connector mechanical stability and to assure electrical insulation.

In the process of selecting a potting compound, the designer made a series of heat and chemical torture tests. One test, to determine the effects of a prolonged, intense heat, was conducted with two potting formulations—one a high quality conventional epoxy resin, the other Dow Epoxy Novolac (D.E.N.* 438). The relays were placed in a 180°C. oven. After five hours, the conventional epoxy resin potting cracked. But after 100 hours of continuous 180°C. heat, the potted terminal made from Dow Epoxy Novolac was unharmed!

To compare the ability of each potting to withstand chemical action, they were soaked in a high-powered degreasing solvent. The ordinary epoxy resin formulation was completely dissolved after only 48 hours in the solvent. But the

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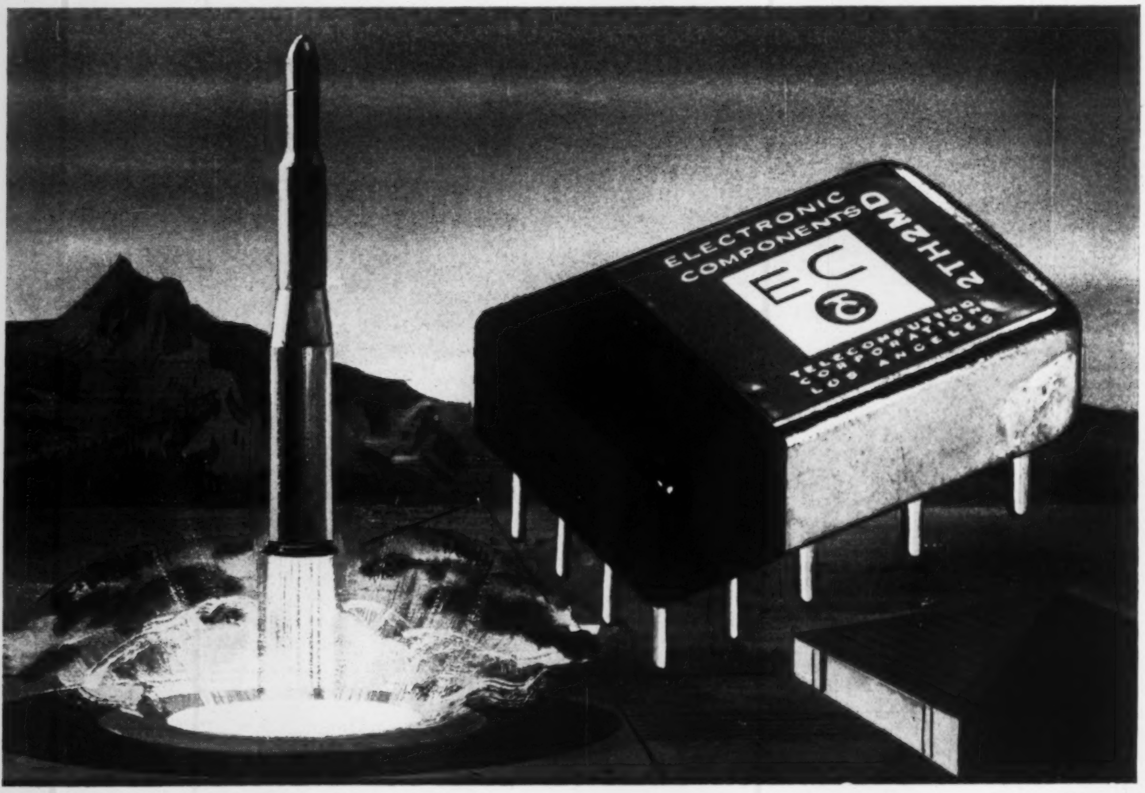


potting made from D.E.N. 438 showed no significant change, even after two weeks' immersion in the same solvent!

Other applications, too. Whether it's for molding, encapsulating or laminating electronic components, or to give coatings and adhesives special qualities, designers are sure to benefit from the hardness, toughness, dimensional stability and chemical resistance of this new Dow polymer.

Other Dow plastics materials are performing equally important jobs helping to maintain the flow of modern business. Dow thermoplastics, for example, are contributing durability, attractive appearance, impact strength, moldability, chemical resistance, and other qualities to adding machines, mechanical pencils and pens, letter baskets, wastebaskets.

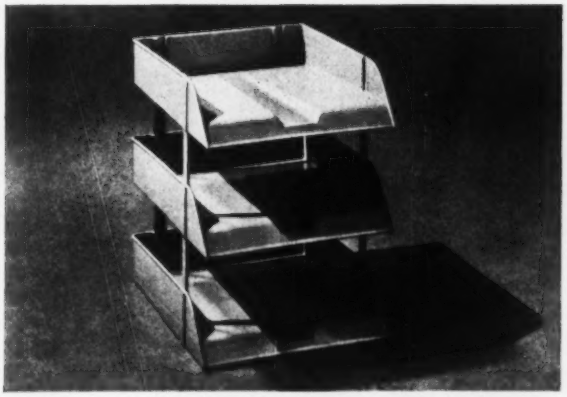
High impact resistance is one of the main qualifications for the cover and front panel of this adding machine. The designer chose a formulation of Dow polystyrene—Styron® 440—for its impact strength and low gloss. Furthermore, the parts made of Styron have built-in color, eliminating a four-step painting operation. The use of Styron 440 has provided a substantial savings in production costs, and combined with the designer's skill, has resulted in an attractive, compact, durable product.

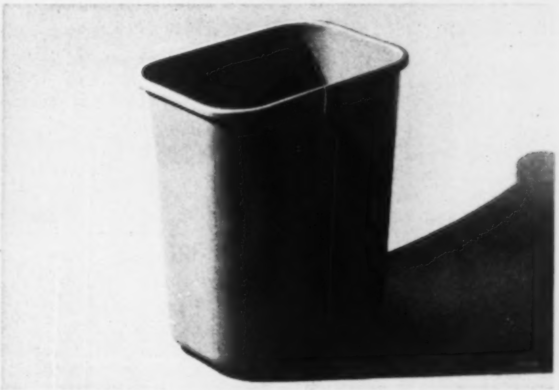
The exceptional moldability of Tyril®, a Dow copolymer of styrene and acrylonitrile, not only gives these pen and pencil barrels an attractive, smooth, glossy appearance, but it enables the manufacturer to achieve a tight plastic-to-metal bond. Molded with finely detailed screw threads, the barrels hold the metal parts with exceptional strength, and can be screwed on and off, again and again without losing their firm grip on the metal.

Another formulation of Styron, Styron 475, gives an exceptionally high degree of impact resistance to a three-tier office letter basket. Styron 475 has three to five times greater impact strength and nine times greater elongation than general-purpose polystyrene formulations. Each tier is held up by thin posts of Styron 475 that fit into slots in the sides of the baskets. The high impact characteristics of this formulation prevent splitting or cracking at these points of stress, and combine this toughness with a pleasing, graceful appearance.

Molded in color, the flexible wastebasket of Dow polyethylene is a natural application of this versatile Dow plastic material. Inert polyethylene makes it sanitary and easy-to-clean, rustproof, noiseless. Available in a wide range of formulations for both molding and extruding, Dow polyethylene provides utility in a wide variety of applications.

Esterbrook





ARE YOU ON RECORD? Have you a design problem that might be solved by one of the versatile Dow thermoplastic or thermosetting materials? If so, drop us a line. We'll be glad to help you with specialized technical service—from choosing the best formulation to assisting in color styling. Write THE DOW CHEMICAL COMPANY, Midland, Michigan, Plastics Merchandising Dept. 1724CD10.

See "The Dow Hour of Great Mysteries" on NBC-TV.

THE DOW CHEMICAL COMPANY

Midland, Michigan

DOW

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MUELLER BRASS CO. PRODUCES

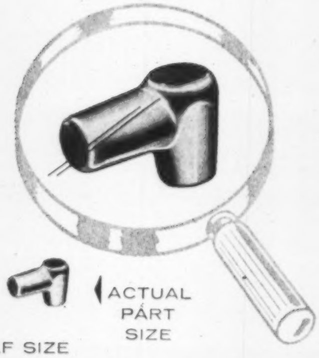
SPECIFICATIONS . . . *REGARDLESS OF*

To obtain the desired physical and design requirements in a part at the lowest cost, there is usually one specific process by which that part can be most successfully and economically manufactured. Because the Mueller Brass Co. offers a variety of production methods, you get sound engineering, accurate production method analysis, our assurance of getting the best product at the lowest cost . . . regardless of metal specified or the size of your particular part.

BRASS, BRONZE, ALUMINUM FORGINGS

The two parts shown here dramatically illustrate the ability of the Mueller Brass Co. to produce precision forgings regardless of size or configuration. Both the tiny dental drill nozzle and the big heat exchanger shell hub, which is the largest of its kind ever produced, were forged to exacting specifications. The weight of the nozzle is only a few ounces while the shell hub weighs 40 lbs., and has a forged pocket $7\frac{15}{16}''$ in diameter and $4\frac{3}{16}''$ deep. By way of size comparison, the pocket is big enough to hold over 14,000 of these tiny drill nozzles. By forging the pocket, considerable machining time and money was saved. The sound, dense structure of the shell hub makes it ideal for the high pressure application for which it was designed. The forging not only does the job better, but was produced for 25% less than the casting it replaced. Experience makes it possible for the Mueller Brass Co. to produce high quality precision forgings regardless of specifications . . . why not put this experience to work for you?

ONE-HALF SIZE



ACTUAL PART SIZE

ONE DEPENDABLE

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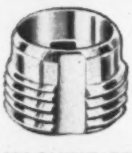


SCREW MACHINE PRODUCTS

POWDERED METAL PARTS

MUELLER BRASS CO.

PARTS ECONOMICALLY...TO EXACT

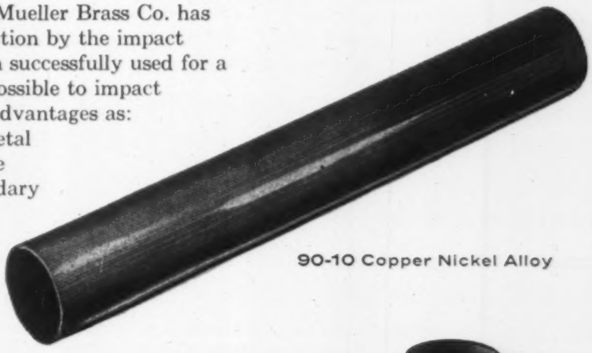
METAL, METHOD OR SIZE...

When you are designing, specifying or purchasing fabricated parts, call in the "Man From Mueller Brass Co." to help lower costs and improve your products. Sales and engineering service is available to you at Mueller Brass Co. offices throughout the United States. Make Mueller Brass Co. your one dependable source for all your part needs.

COLD PREST® IMPACT EXTRUSIONS

Today, because of vast experience in alloys, the Mueller Brass Co. has greatly expanded the possibilities of parts production by the impact extrusion method. Aluminum, of course, has been successfully used for a multitude of tubular shapes. But now it is also possible to impact parts of copper alloys incorporating such major advantages as: closer tolerances, better finish and appreciable metal savings. Because of dimensional accuracy possible with the impact extrusion, the necessity of secondary machining operations is often eliminated.

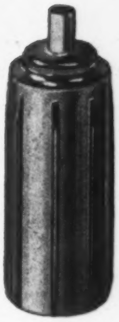
The parts shown here are representative of the group now being economically produced as impact extrusions by the Mueller Brass Co. who offer complete engineering and design service in the development of new parts from copper base alloys.


90-10 Copper Nickel Alloy

Aluminum Alloy 6061

Oxygen Free High Conductivity Copper

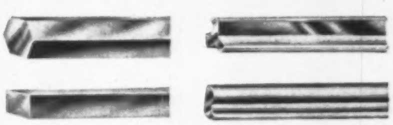
Special Alloy 902


Tellurium Copper Alloy

Low Phosphorus Copper Alloy

SOURCE FOR ALL THESE OTHER PRODUCTS

FORMED COPPER TUBE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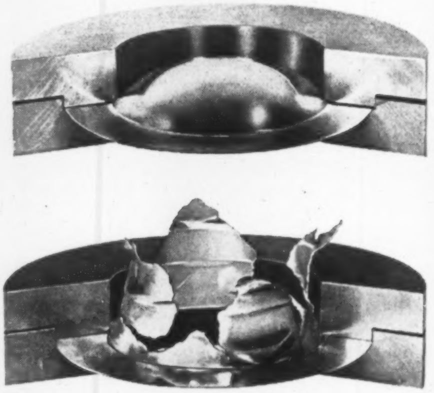

In pressurized apparatus subject to corrosive action, precious metal rupture discs provide the safest, most accurate and dependable relief. Platinum, gold, and silver are now generally recognized as specifics when dealing with corrosion. Each is resistant to the corrosive effects of an important group of liquids and gases and will remain unattacked under conditions that would render many base metal materials useless. These rupture discs, depending on material selected, are guaranteed to be burst ±5% of specified pressure. Intrinsic value adds to the original cost of these discs but the actual metal value is recovered, no matter how torn or battered the discs may be. Send for literature.

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fine wire, thin foils, ribbon and tubing in noble metals and their alloys, for all applications.

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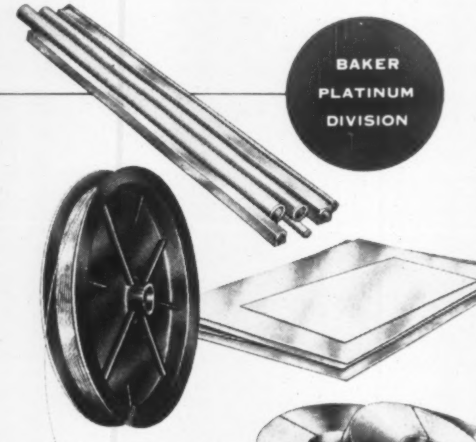

The unique combination of properties of the noble metals continually recommend them for industrial applications. Our modern melting, wire drawing, rolling and heat treating equipment coupled with long experience in the field is at your service for production of standard and special items.

WIRES: Bare drawn wire of ductile materials down to .004" —High temperature thermocouple wires—High temperature furnace windings — Potentiometer and Resistance wires — Platinum clad tungsten wire.

FOILS: In platinum, palladium and gold down to .0001"— In iridium and rhodium as thin as .001".

TUBING: Seamless in platinum, palladium, gold and their alloys. Sizes from .018" with .004" wall up to 1½" with .042" wall.

For complete information write for our leaflets, "Fine Wire, Foils, Ribbons" and "Noble Metal Thermocouple Wire".

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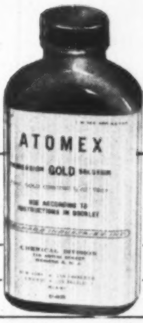
CHEMICAL DIVISION



gold plating for electrical and electronic components

Atomic Number	79
Atomic Wgt.	197.20
Crystal Structure	Face center cubic 4.07A°
Density	20°C = 19.3 G/CM³
Melting Point	1063°C
Specific Resistance	13.2 OHMS/MILL/FOOT
Thermal Conductivity	0.71 c g s UNITS (20°C)
Coef. Linear Expansion	14.2 Micro Inches /°C (20°C)
Hardness	Rockwell 15 T Scale = 24
Tensile Strength	P.S.1 x 1000 = 18
Magnetic Susceptibility	.15 x 10^{-6} C.G.S. Units (18°C)

Recently, the use of gold electroplates have been extended to many new functional applications especially in the field of electronics where the tarnish resistance and low electrical resistivity of gold are most useful. A complete line of precious metal plating solutions for both decorative and functional purposes are available from stock.

ATOMEX is a 24K gold immersion solution that permits the deposition of a thin, dense, uniform layer of 24K gold on printed circuits and metallized plastics by means of a simple bath. Atomex deposits.gold by Ionic displacement—it is the first practical gold immersion solution containing no free cyanide. The Atomex deposit is more permanent and less expensive than electroplating of comparable thickness. Costly analytical control is unnecessary. Write for literature.

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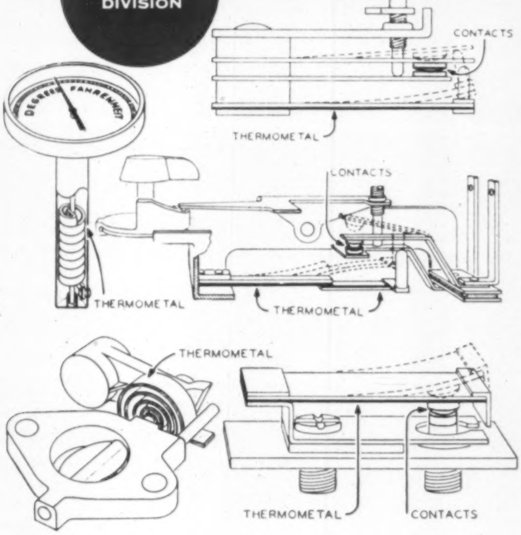

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REPUBLIC COLD EXTRUSION QUALITY STEEL

. . . steel that cuts your cost of production

Republic Steel—largest producer of the nation's widest range of bar products—has a new, 11″ bar mill in Chicago that specializes in steel for cold extrusion and cold heading. Features that save you money:

1 **UNIFORM FLOW CHARACTERISTICS**—carbon and alloy steels produced on this mill have denser, more uniform structures because they undergo more hot work. Bigger than usual billets, 3″ and 4″ square, become finished products of standard size.

2 **PRECISE DIMENSIONAL ACCURACY**—16 alternating vertical and horizontal stands with roll neck bearings are utilized to exert uniform pressure on all sides of the bar. This process, along with vertical looping above the mill, eliminates deformations.

3 **ANNEALED, NORMALIZED, SPHEROIDIZED**—new continuous annealing furnaces, capable of all types of furnace treatments, are designed for rigid control of speeds, temperatures, and atmospheres. Other facilities are available to pickle, oil, lime, phosphate, and borax coat bar products.

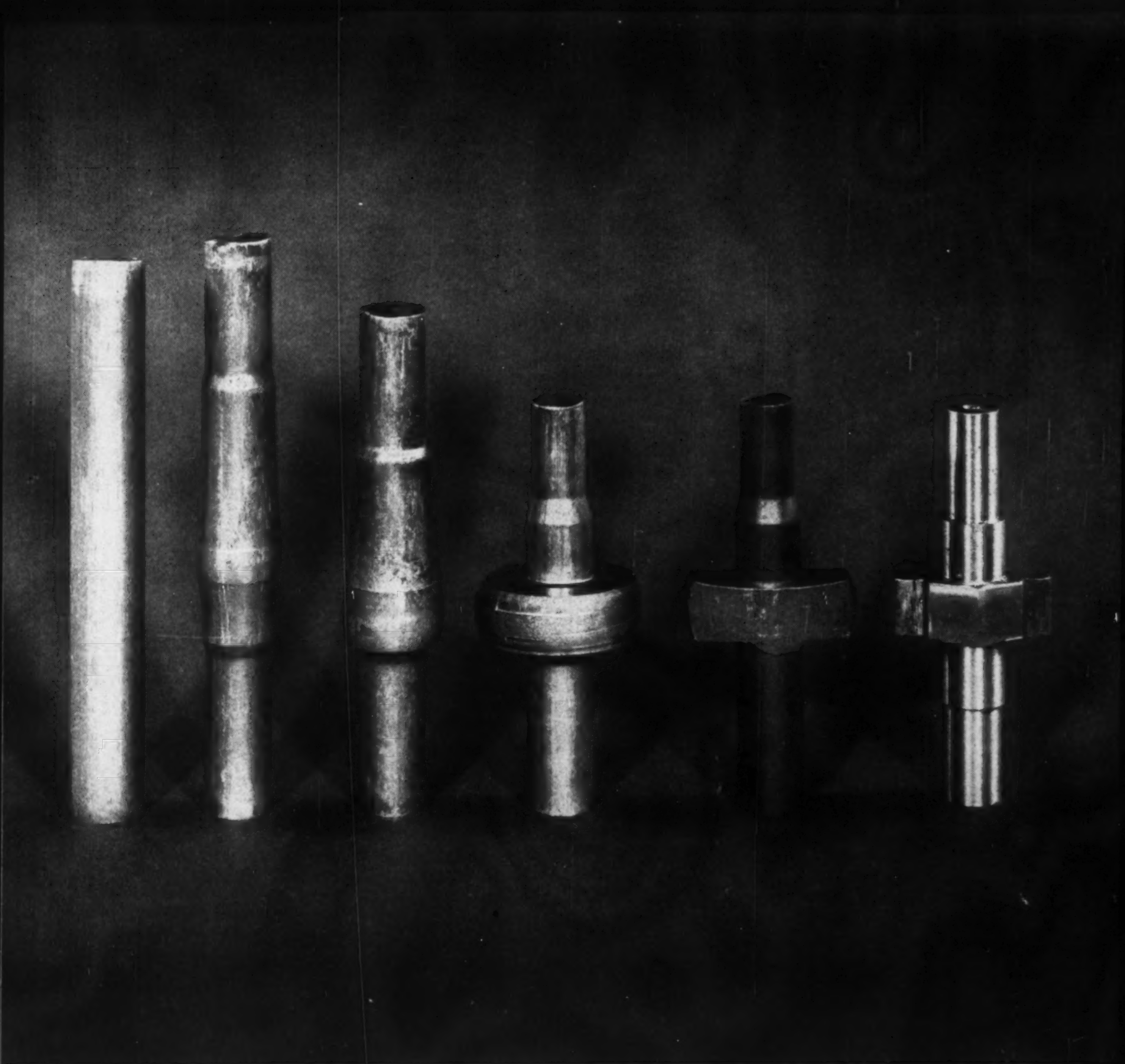
4 **1600-POUND, DOUBLE-BANDED COILS**—four high-speed coilers handle the complete range of coils produced (⅜″ to 39/64″—700 to 900 pounds, ⅝″ to 1½″—1400 to 1600 pounds). Bigger coils cut downtime and scrap loss. Double banding simplifies your handling.

5 **CAPACITY TO MEET YOUR REQUIREMENTS**—this 11″ bar mill produces bar products at rates of up to 3000 feet per minute. Annealing furnaces are the continuous type, capable of meeting the growing demand for furnace-processed steel.

COLD FINISHED, TOO!

Depending upon the nature of your product and the method by which it is made, you may find it more advantageous to use cold extrusion quality steel in *cold finished form,* as did the manufacturer of this gear.

We would welcome an opportunity to serve you on your requirements for both hot rolled and cold finished, cold extrusion quality steel. Our metallurgists will help you select the most economical carbon, alloy, or stainless steel capable of meeting your requirements. For complete data, call your nearest Republic sales office or mail the coupon.



CUTTING THE COST OF A SEGMENT GEAR: ideal blanks are produced by cold heading, cold extrusion, and upsetting. Stock with upset in the center is hot trimmed on a press, after which it is machined into the finished part. Only a minimum of stock need be removed during final machining. Photo courtesy of National Machinery Company, Tiffin, Ohio.

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World's Widest Range

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Joe Foster, President,
offers customers Foster Grant's
41 years of molding experience.

"Let me tell you about the world's largest plastics laboratory," says Joe Foster.

That's what customers call our molding room — a **plastics 'laboratory.'**

I'd have to agree with them, too, because I know that we're the only company serving the plastics industry both as a manufacturer of polystyrene, impact polystyrene and Nylon 6 resins, **backed by 41 years of molding know-how.**

This means that as the world's largest manufacturer of sunglasses we use our own powder to mold with. And, believe me, since we introduced injection molding to America in 1931, we've met just about every molding problem in the book.

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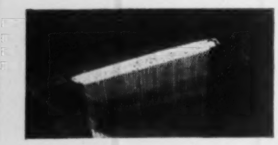
Drawing molten glass into 300,000,000 miles of fiber

In this glass fiber drawing process at Gustin-Bacon Manufacturing Company, only a platinum alloy can provide the properties so necessary for the critical furnace. The platinum alloy bushing delivers 16 months service, forms about 300,000,000 miles of fiber.

Where any metal but Platinum would cost too much...



This furnace, or "bushing", is so hot it glows like a fluorescent light. It is designed to act as a resistance heating element to bring the glass to a fluid state, to maintain its critical viscosity.

There are hundreds of tiny holes in the glowing metal, through which molten glass flows to be formed into glass fibers — fibers as fine as .00004" in diameter. *Every minute 10,000 feet of each fiber is formed.*

This metal has to endure severely oxidizing conditions. Crippling temperatures. The eroding effect of streaming molten glass. What metal could provide long enough life . . . be economical enough?

Engineers at Gustin-Bacon — manufacturers of glass fibers — found that a rhodium-platinum alloy was the only metal that could handle this flow of molten glass month after month.

The reasons? This platinum alloy has a melting point well above 3000°F. At fiber drawing temperatures (2400°F) it retains its strength and toughness, provides a hard, wear-resisting surface. Uniform fibers are produced because this alloy doesn't erode or corrode. Doesn't degrade quality.

And after 16 months of continuous service the precious metal is reclaimed and returned to service with only about 1 to 1½% of the platinum alloy lost.

Metal that masters molten glass may master a problem for you

Where conditions involve high temperature, or where a combination of severe erosion and corrosion must be met — as in the production of glass fiber; or where hard, highly conductive surfaces are required — as in the production of printed electrical circuits; or where peak catalytic efficiency is required—as in the refining of high octane gasoline . . . the platinum metals often prove to be the most economical materials for critical equipment.

Perhaps your own progress has been blocked by the limitations of materials to withstand such severe conditions. If so, platinum, palladium, rhodium, ruthenium and iridium — all possessing unique combinations of properties—are well worth your attention and consideration.

Specialists are prepared to work with you in evaluating these metals for new commercial and scientific uses. As a first step, write us for additional data on the outstanding characteristics and successful applications of the six platinum metals and their alloys — indicating your field of interest or how we might be of assistance.

CAN THESE PROPERTIES OF THE PLATINUM METALS HELP YOU?

High Temperature Stability
Superior Wear Resistance
Exceptional Chemical Inertness
Peak Catalytic Activity
Low Vapor Pressure

The six platinum metals are:

PLATINUM • PALLADIUM • RHODIUM • RUTHENIUM • IRIDIUM • OSMIUM

INCO PLATINUM METALS DIVISION

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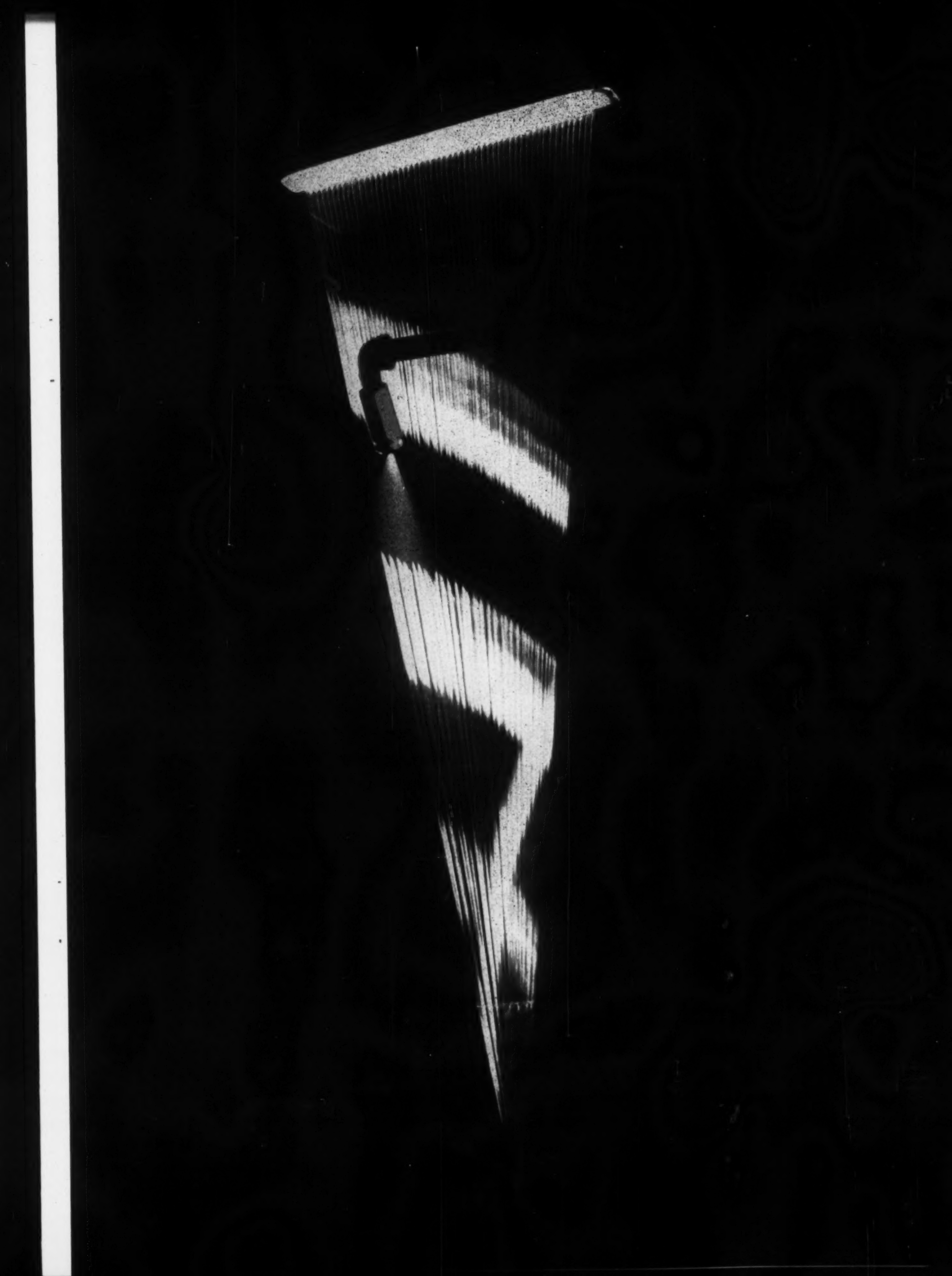
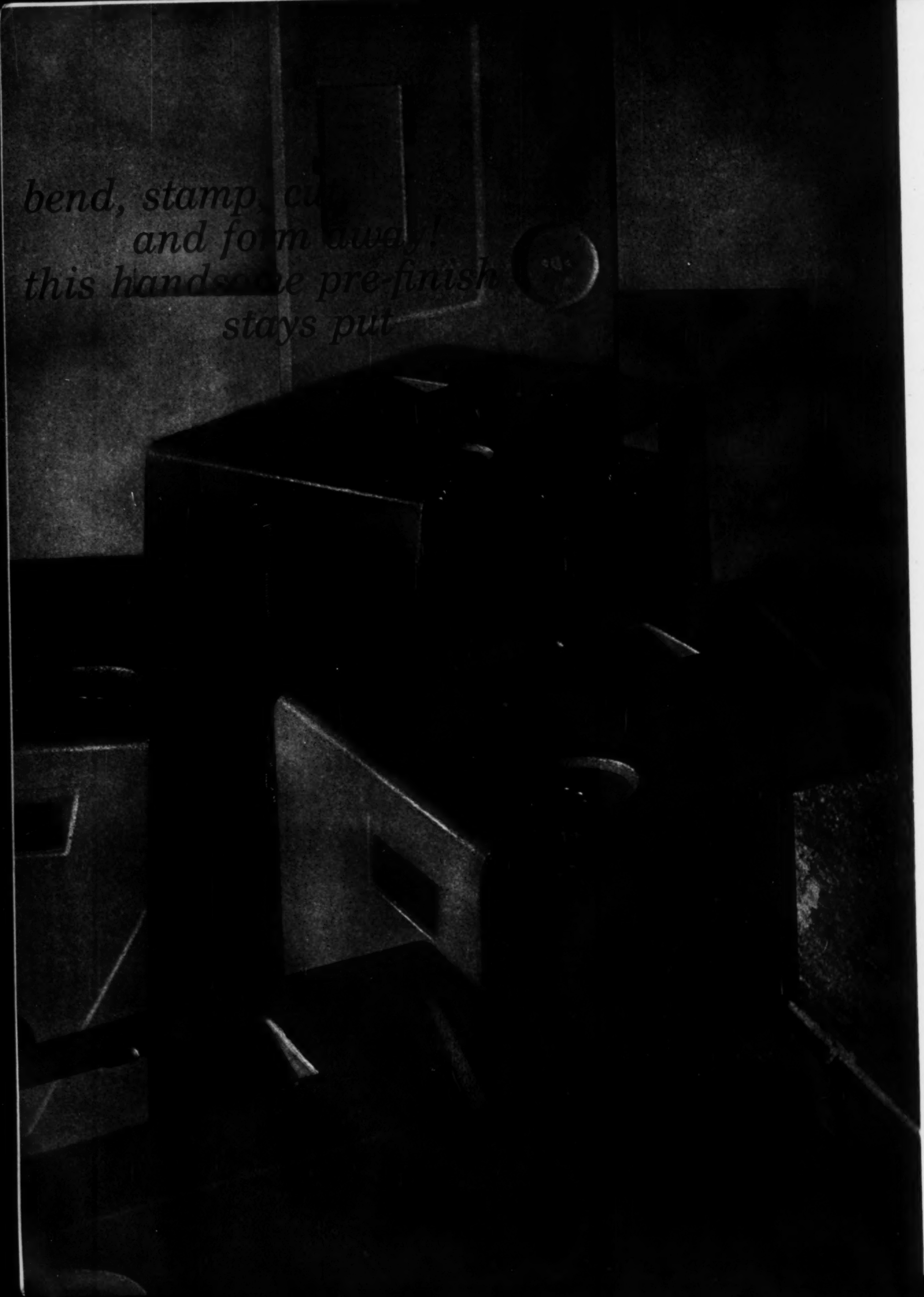
The International Nickel Company, Inc., 67 Wall Street, New York 5, N.Y.

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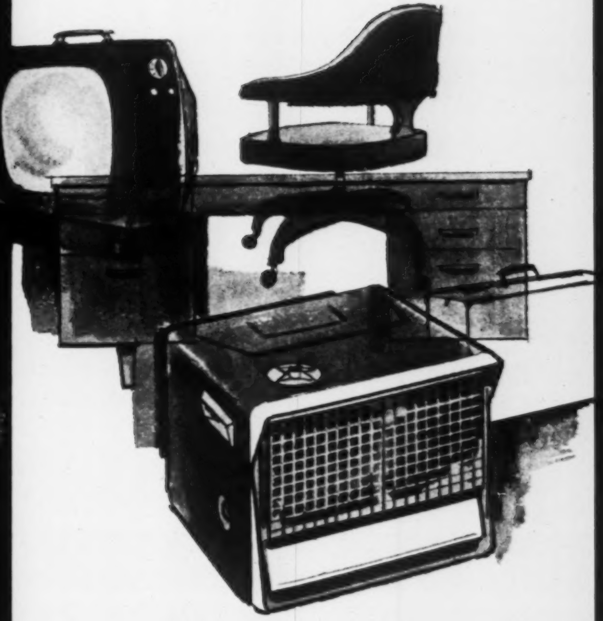
and form away!
this handsome pre-finish
stays put

VINYL-ON-METAL is cooperative. Stamp it out. Punch it out. Even weld it! Form it the same ways you form unfinished sheets. The unique colors, textures and patterns of Vinyl-on-Metal sheeting or coils remain unaffected. The tough resilient surface stays—won't chip or peel in use. It protects against tearing or wrinkling—minimizes surface damage during fabrication and assembly. Vinyl-on-Metal is already widely and successfully used for furniture appliances, transportation interiors, building construction, and in many other fields. For a highly informative booklet, "Vinyl-on-Metal," write to Monsanto Chemical Company, Plastics Division, Room 753, Springfield 2, Mass.



Monsanto developed and today supplies Opalon® and Ultron® vinyls for superior finishes on steel, aluminum, and other metals, and on wood, paper and glass.

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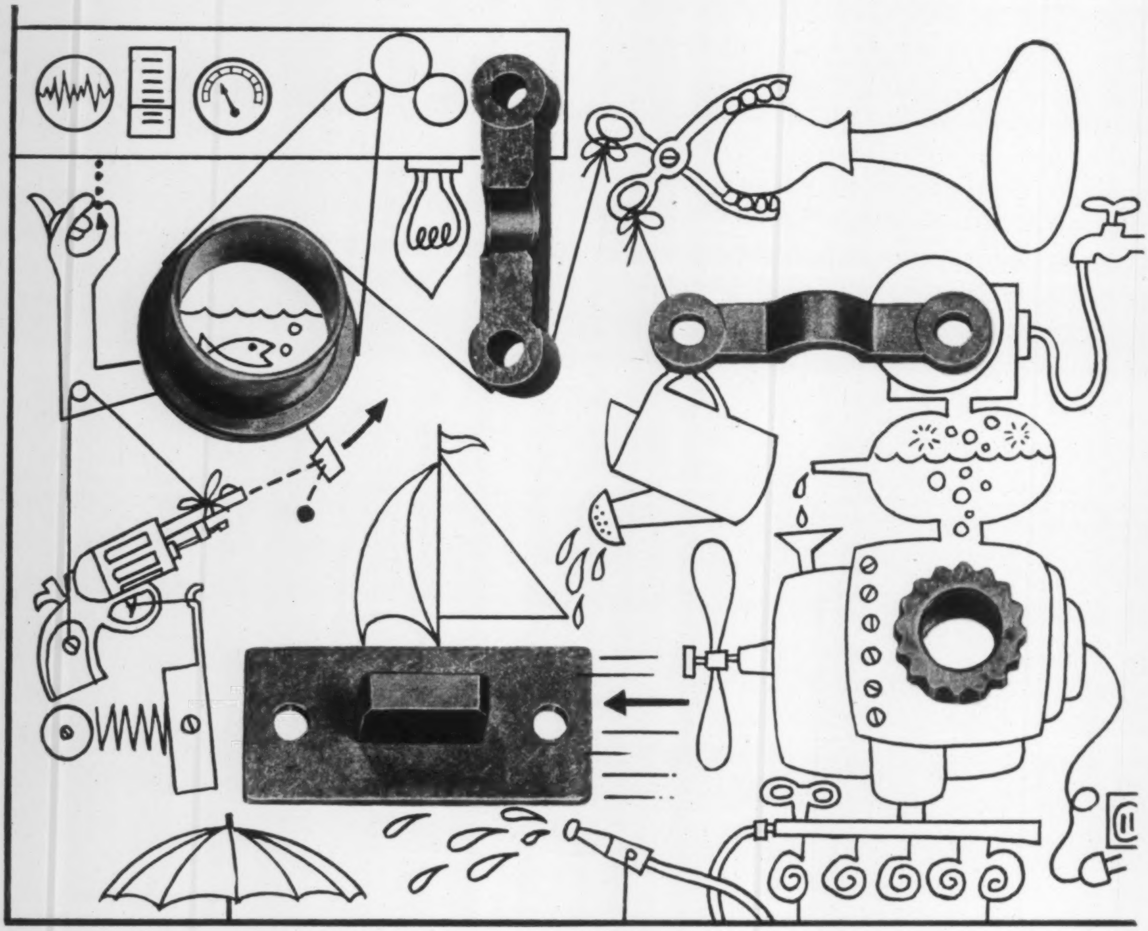

This thing wouldn't run when we plugged it in,

BUT, WE'D LIKE TO SEND YOU THE PIECES*

. . . to introduce you to parts made from superior Glidden Resistox Metal Powders.

You may find that metal powder parts similar to these, or perhaps in entirely different form, can mean substantial savings in manufacture of your products.

Glidden Resistox Metal Powders are prepared by a special process which removes *all* soluble salts, resulting in pure, stable powders for highest finish, appearance and performance characteristics.

Glidden is the world's largest blender and can produce up to 30,000 pounds of powder in a single batch—an important factor in complete uniformity of mass-produced parts.

As a leading supplier of metal powders, Glidden works closely with parts producers. This places the combined training and experience of several staffs of metallurgists and technicians at your disposal.

**Write on your letterhead for sample parts package and further information on powdered metal products.*

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The Glidden Company
Chemical Divisions, Metals Department
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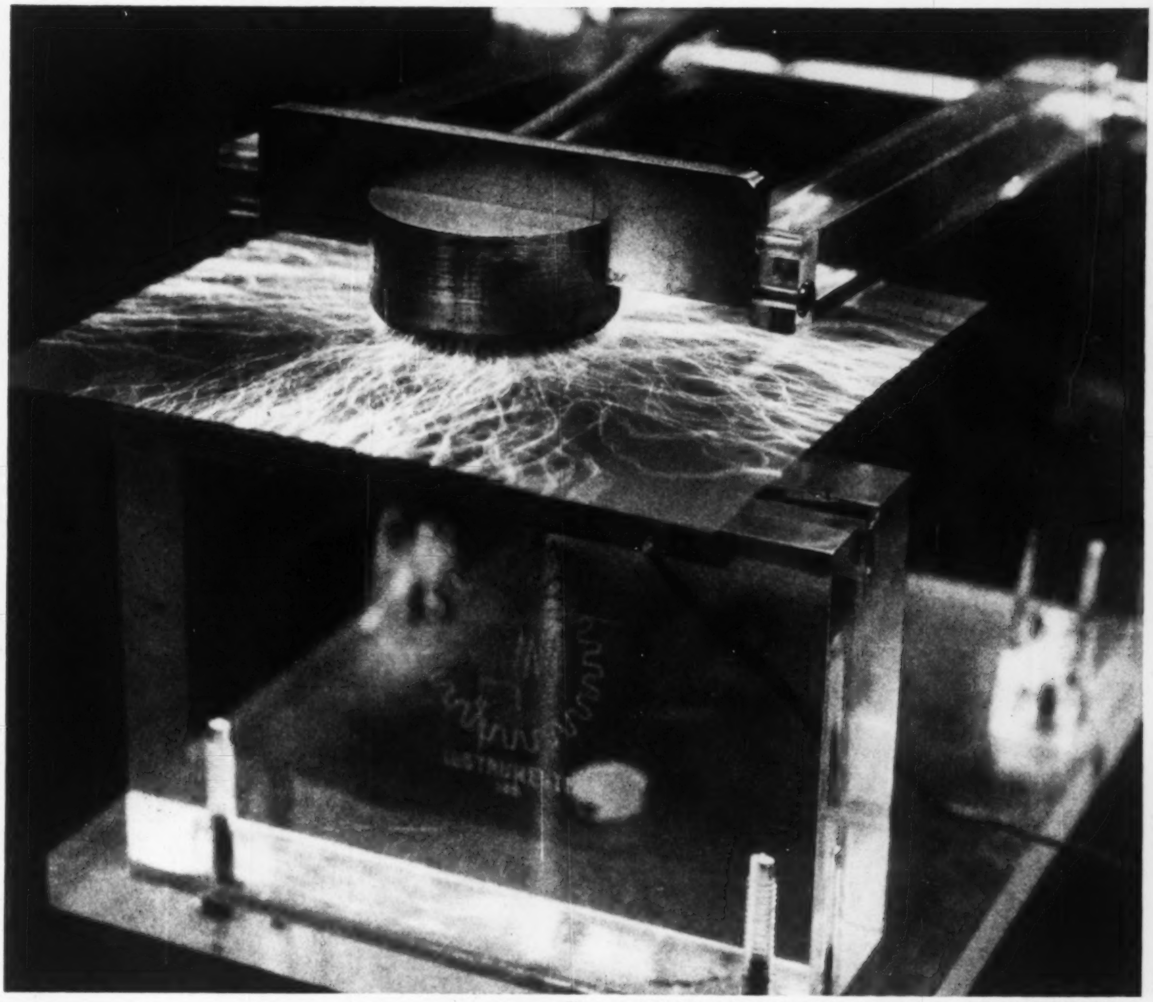

This is an actual photograph of "Mylar" undergoing dielectric strength test (per ASTM-D-149).

MYLAR® has a dielectric strength of 4,000 volts per mil

Can the unique combination of properties found in "Mylar" help you solve your design problems?

High dielectric strength helps cut capacitor size. Tough, thin "Mylar" with a dielectric strength of 4,000 volts per mil for 1 mil film (per ASTM-D-149) permits capacitor manufacturers to reduce size of finished unit . . . improve performance and reliability.

"Mylar"* polyester film is a tough, flexible engineering material. In addition to its outstanding dielectric strength, "Mylar" has an average tensile strength of 20,000 psi, withstands temperature extremes (-60° to 150° C.) . . . resists most chemicals and moisture.

On an area basis, tough, thin "Mylar" often *costs less* than heavier, conventional materials. "Mylar" can be laminated, embossed and metalized, punched or coated. The film won't embrittle with age. "Mylar" is available in roll or sheet form in a wide range of gauges.

Find out how the *combination of properties* in "Mylar" can help you solve knotty design problems, improve product performance or cut costs. Write for our booklet containing detailed information on properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room M-10, Wilmington 98, Del.

"Mylar" is Du Pont's registered trademark for its brand of polyester film.

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. . . THROUGH CHEMISTRY

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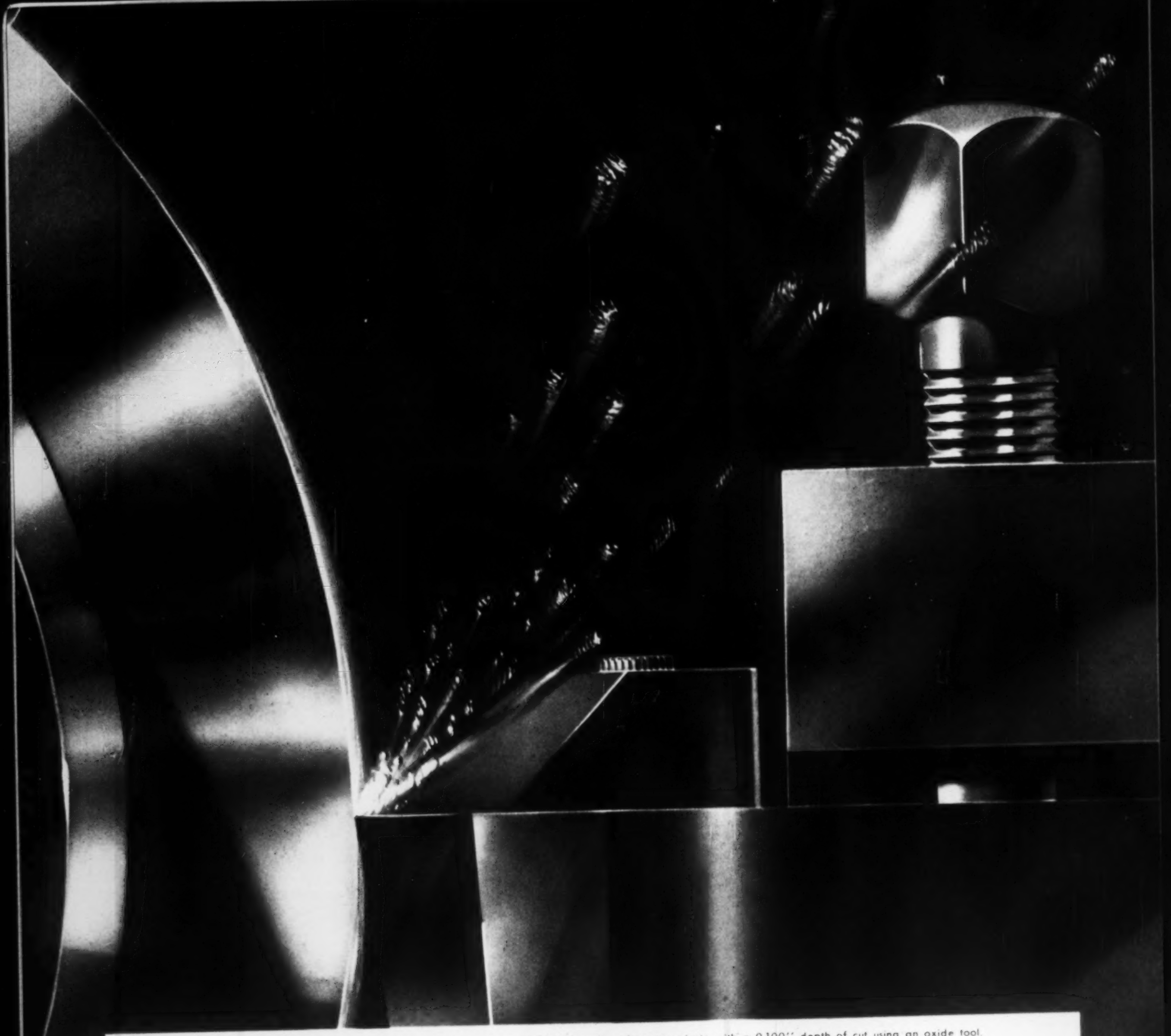


Illustration of Malleable casting being turned at 1,400 surface feet per minute with a 0.100'' depth of cut using an oxide tool.

Cut Machining Time and Costs . . . Use Malleable

It's the **finished** cost of machined components that's important to you. Remember then . . . Malleable iron is the most readily machinable of all ferrous metals of similar properties. With Malleable castings you'll reduce machining time as much as 50% . . . increase tool life up to 250% . . . get unexcelled surface finishes.

Find out how much you can cut **your** finished parts costs. Contact any nearby Malleable castings producer who displays this symbol—

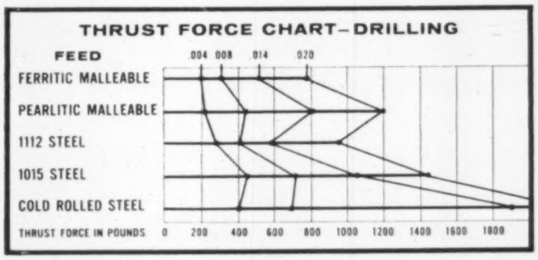
MEMBER
MALLEABLE
CASTINGS COUNCIL

For detailed information on "Machinability of Malleable Castings", contact any of the progressive companies listed on the opposite page, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

You'll Get Faster Machining...Better Finished Surfaces... Longer Tool Life with Malleable Castings

Whatever your machining goals—reduced cycle times, lower tool costs or better surface finishes, you will profit from remembering this fact: Malleable is the most machinable of all ferrous metals of comparable properties.

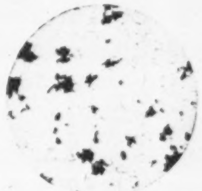
For example, compare the force required to drill Malleable with that required to drill other commonly used metals as we have done here—



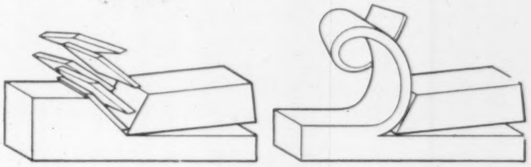
For this test we used ½ inch high speed steel twist drills with a suitable lubricant and a spindle speed of 715 RPM. AISI 1112 steel (Bessemer screw stock) was included because it is often used as a standard for machinability comparisons. Since machining may cost 2 to 4 times as much as the rough parts, the superior machinability of Malleable iron, as demonstrated here, can result in very large savings.

Chips Reveal the Secret of Malleable's Machinability

In addition to providing strength and ductility, Malleable's internal structure of microscopic carbon nodules allows Malleable to break easily into small chips as it is machined. This kind of Type I chip is highly desirable. Speeds and feeds can be increased . . . power consumption drops . . . cutting tools last longer. Malleable's uniform structure permits safe machining at maximum speeds.



Spherical carbon nodules (black) help break up chips. Photomicrograph 50X, etched.



Schematic drawing illustrates how Malleable (left) breaks into short, discontinuous Type I chips, rather than long, continuous Type II and III chips (right).

Future Promises New Triumphs for Malleable

With over two years' experience in advanced machining research, forward-looking Malleable castings producers already know how Malleable will perform when oxide cutting tools come into wide use. In experiments like the one illustrated on the opposite page it has been demonstrated that Malleable can be successfully machined at speeds as high as 1400 surface feet per minute and a 0.100″ depth of cut! Surface finish, tool life and metallurgical structure are excellent . . . All this in a metal of rugged engineering properties.

Prove for yourself how much Malleable's machinability will do for your products . . . and your profits. Get in touch with one of the Malleable castings producers listed below. Call today.

Send for Free Machining Information—A special folder, *Data Unit 106, Machining Malleable Iron Castings*, is available from the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio, or from any member company.

For Quality and Economy...Use MALLEABLE

For Service In Your Area Contact...

CONNECTICUT

Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE

Eastern Malleable Iron Co., Wilmington 99

ILLINOIS

Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA

Albion Malleable Iron Company,
Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Mall. & Steel Castings Co., Indianapolis 22

IOWA

Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS

Belcher Malleable Iron Co., Easton

MICHIGAN

Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA

Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI

Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE

Laconia Malleable Iron Co., Laconia

NEW YORK

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Frazer & Jones Company Division
Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO

American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA

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Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS

Texas Foundries, Inc., Lufkin

WEST VIRGINIA

West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN

Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

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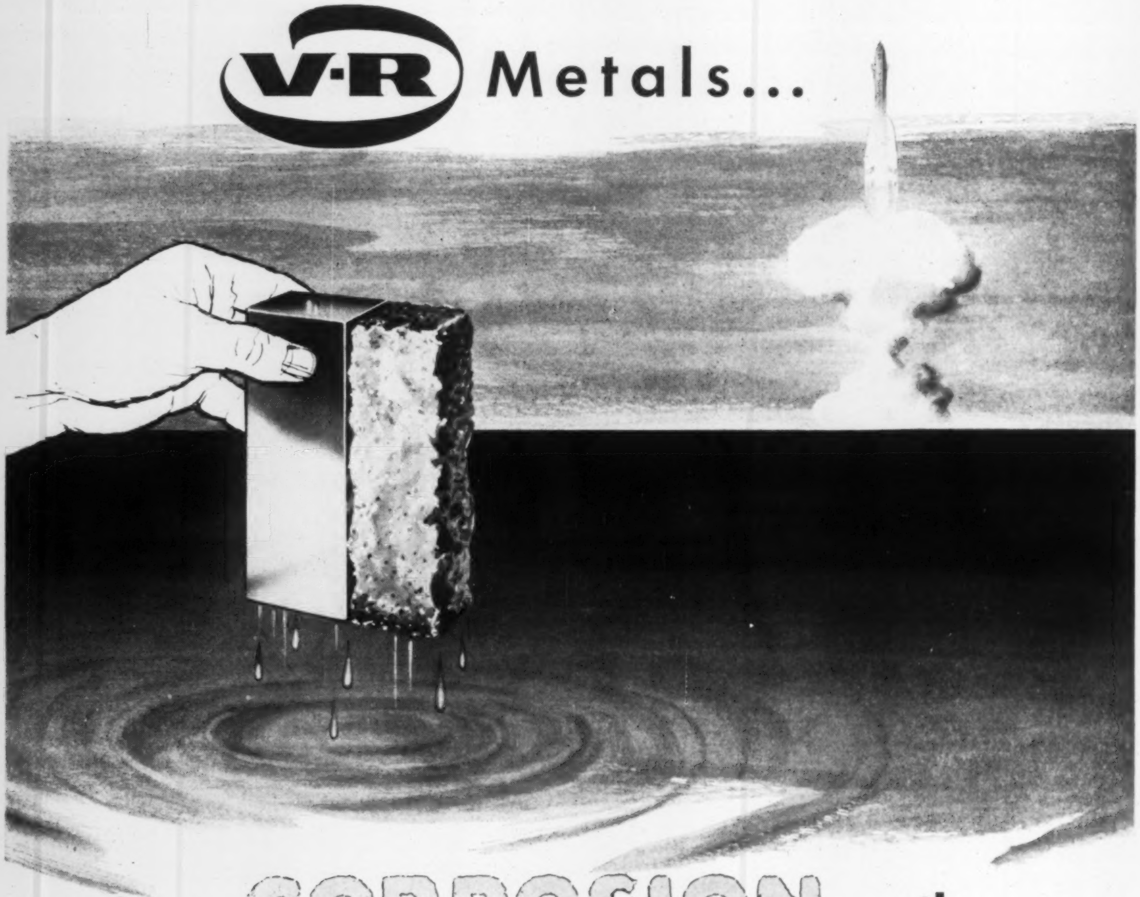
V-R Metals...

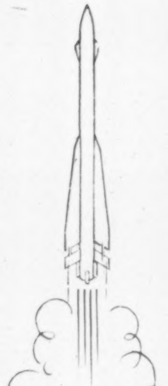


when CORROSION strikes...

Metals of tomorrow ...TODAY!

Vascoloy-Ramet, pioneering manufacturer of refractory metals, is making a substantial contribution to today's advancing metallic age. V-R is creating and developing special metals with exceptional characteristics to meet the ever-changing demands of industry. Thirty years of V-R research, engineering, and manufacturing experience have produced the metallurgical knowledge built into all V-R products. This same experience and knowledge is working full time to meet the needs of tomorrow.

A-798



Vascoloy-Ramet creates metals that are impervious to corrosion. V-R also creates metals that possess amazing stability at extreme temperatures, high rigidity under load, extremely low coefficients of expansion, ultra-high density and controlled uniformity.

Yes, many of today's metal requirements are met by Vascoloy-Ramet. V-R designs these sintered and alloyed materials to fill your metal requirements. Many engineers are utilizing V-R assistance for metal design assurance.

For additional information, contact V-R today.

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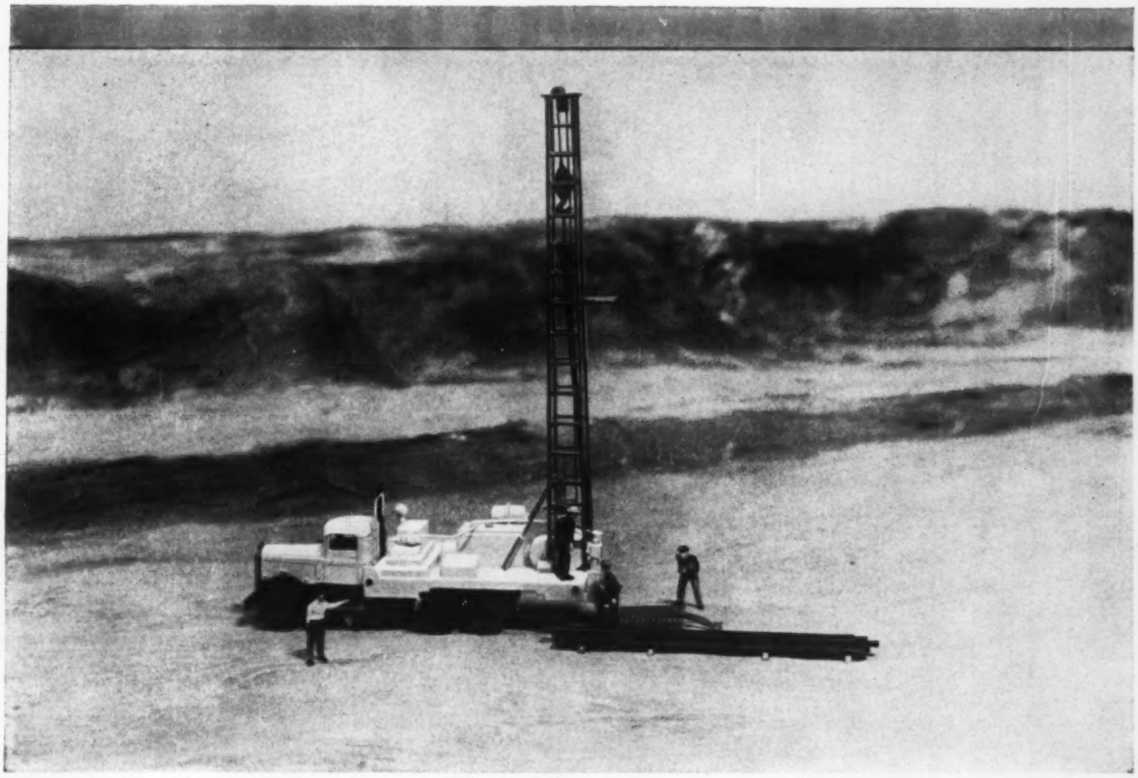


Down-to-earth reasons for using Custom Quality OHIO Tubing

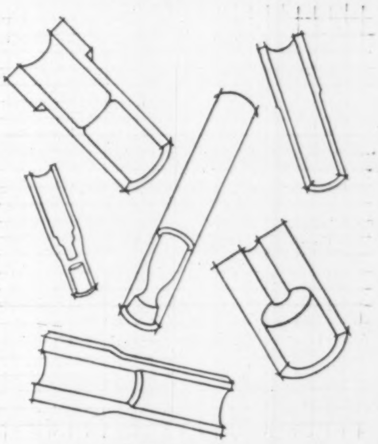
As in rotary drilling, which uses steel tubing internally upset by Ohio Seamless, greater strength and lighter weight may be important in your product.

So before selecting a tubing source consider these important facts. OHIO Tubing is always the exact tubing you need for your product because OHIO Tubing is CUSTOM MADE for your product. Your order is manufactured to your own specifications to produce steel tubing especially for your application — the precise grade, analysis, size, shape, special anneal and tolerances best suited to your needs.

Ohio Seamless Tube produces both seamless and electric welded steel tubing — is prepared to form many finished or semi-finished tubular parts to your designs.

To get the most from your next steel tubing order, use Custom Made OHIO Tubing. Contact your nearest Ohio Seamless representative, or send part drawings to the plant at Shelby, Ohio — Birthplace of the Seamless Steel Tube Industry in America. A-3061A

Model illustrated built to 3.5 mm scale.



Typical Ohio Seamless tubular upset forgings

OHIO

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Seamless and Electric Resistance Welded Steel Tubing • *Fabricating and Forging*

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CANADA: Railway & Power Engr. Corp., Ltd. • **EXPORT:** Copperweld Steel International Company, 225 Broadway, New York 7, New York

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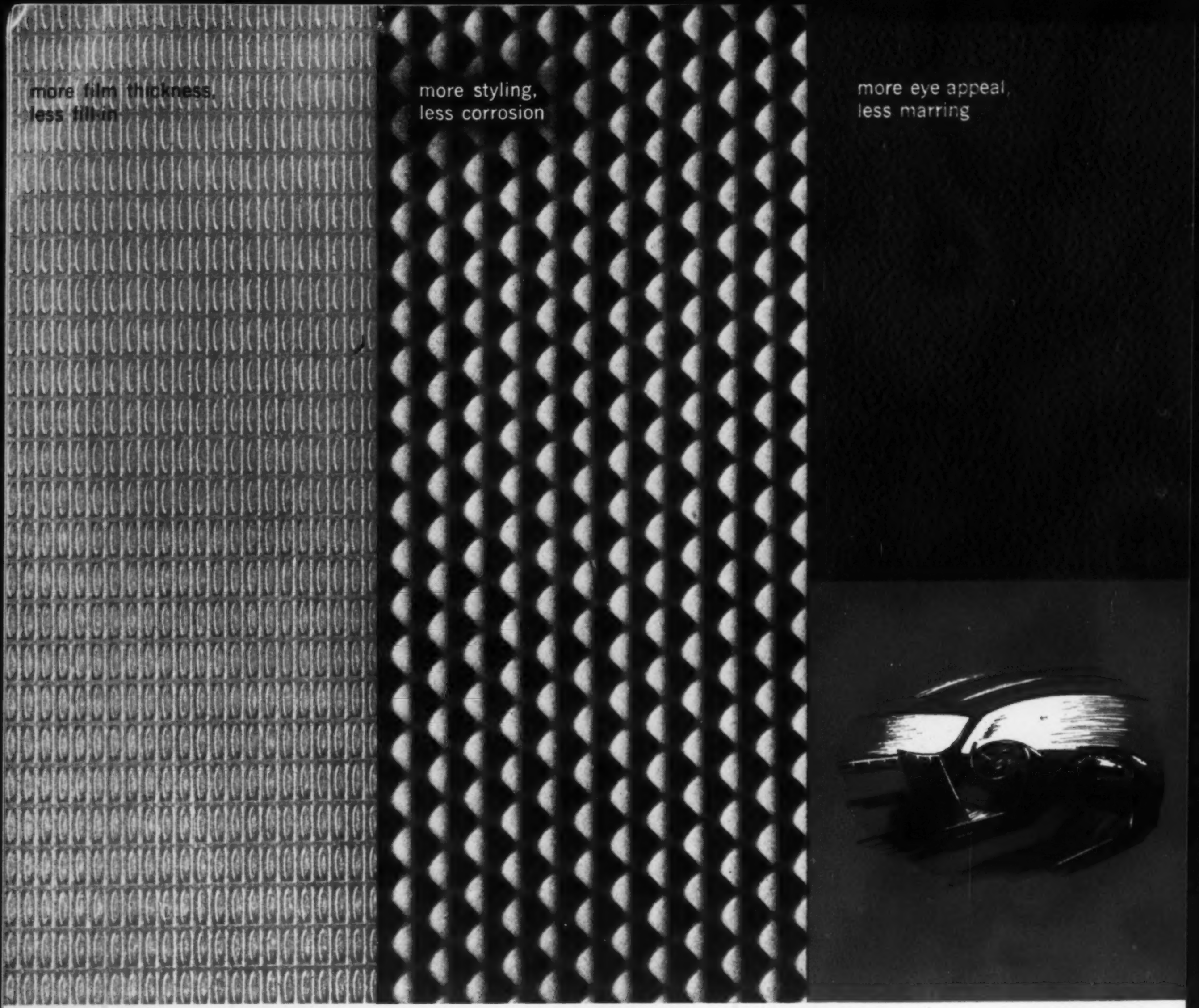

Made for each other . . . metal plus M&T Spray-on Vinyl Finishes

PATTERN ADDS RICHNESS, STYLE, interesting dimension to metal. And now you can protect, and at the same time faithfully mirror a patterned metal, or add distinctive pattern to smooth metal —thanks to M&T sprayed-on, abrasion-resistant, vinyl finishes.

But these thick-film coatings add more than good looks and warmth. They *multiply* service life because they will not chip, corrode, mar, stain or fade. And since the product is coated at the end of the production operation, there are no unsightly raw edges—no problems with welding and forming. Typical use: automotive interiors.

Two types of M&T vinyl finishes are available: one for application to the mill-patterned or perforated metal of your choice; the other for a leather-like texture on smooth metal. Any color, of course. Send for more data.

M&T **coatings and finishes**
METAL & THERMIT CORPORATION
General Offices: Rahway, New Jersey

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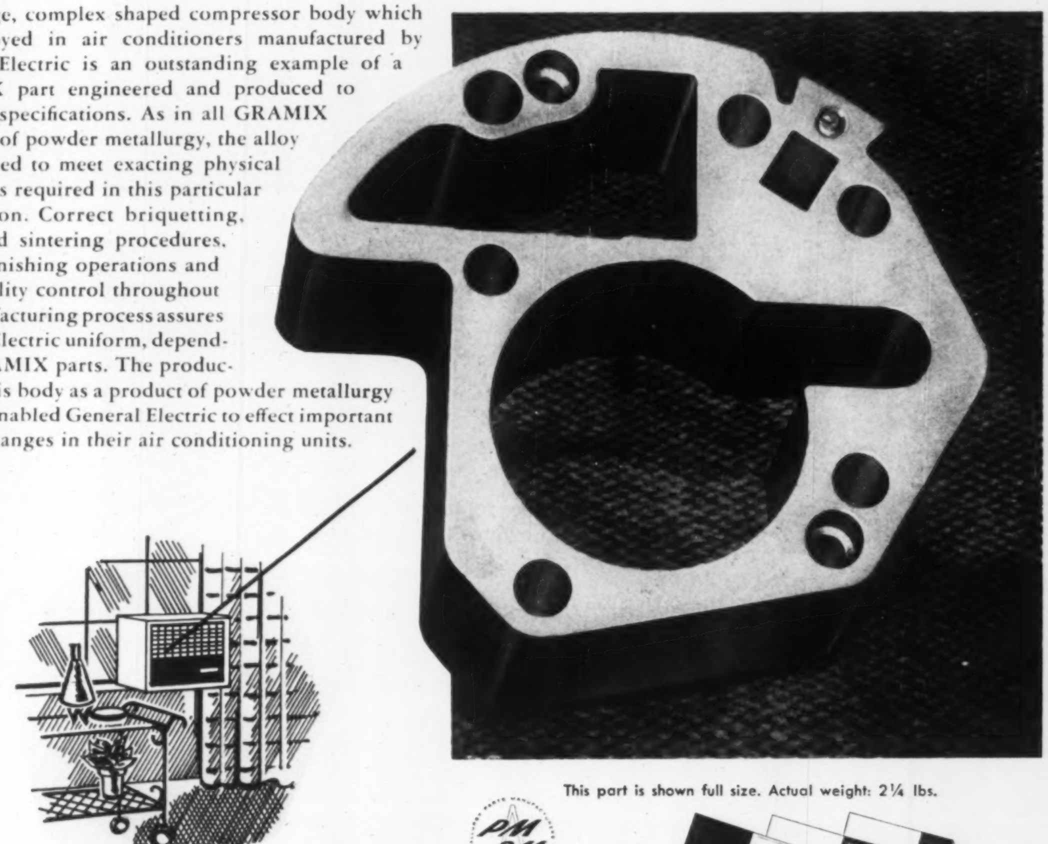
GRAMIX® COMPRESSOR BODY IS VITAL PART IN GENERAL ELECTRIC AIR CONDITIONER

. . . this GRAMIX part is a new concept in powder metallurgy techniques . . . engineered to meet requirements of GENERAL ELECTRIC's new compressor design

This large, complex shaped compressor body which is employed in air conditioners manufactured by General Electric is an outstanding example of a GRAMIX part engineered and produced to exacting specifications. As in all GRAMIX products of powder metallurgy, the alloy was created to meet exacting physical properties required in this particular application. Correct briquetting, controlled sintering procedures, precise finishing operations and rigid quality control throughout the manufacturing process assures General Electric uniform, dependable GRAMIX parts. The production of this body as a product of powder metallurgy has also enabled General Electric to effect important design changes in their air conditioning units.



This part is shown full size. Actual weight: 2¼ lbs.

Write today for these helpful engineering manuals. Engineering Bulletin No. 18 covers design and metallurgical requirements and alloy selection of GRAMIX bearings. No. 19 contains facts about GRAMIX Machine Parts and No. 21 contains general information on GRAMIX products from Powder Metallurgy. Get your copies now.

X-274-1

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Kanigen®

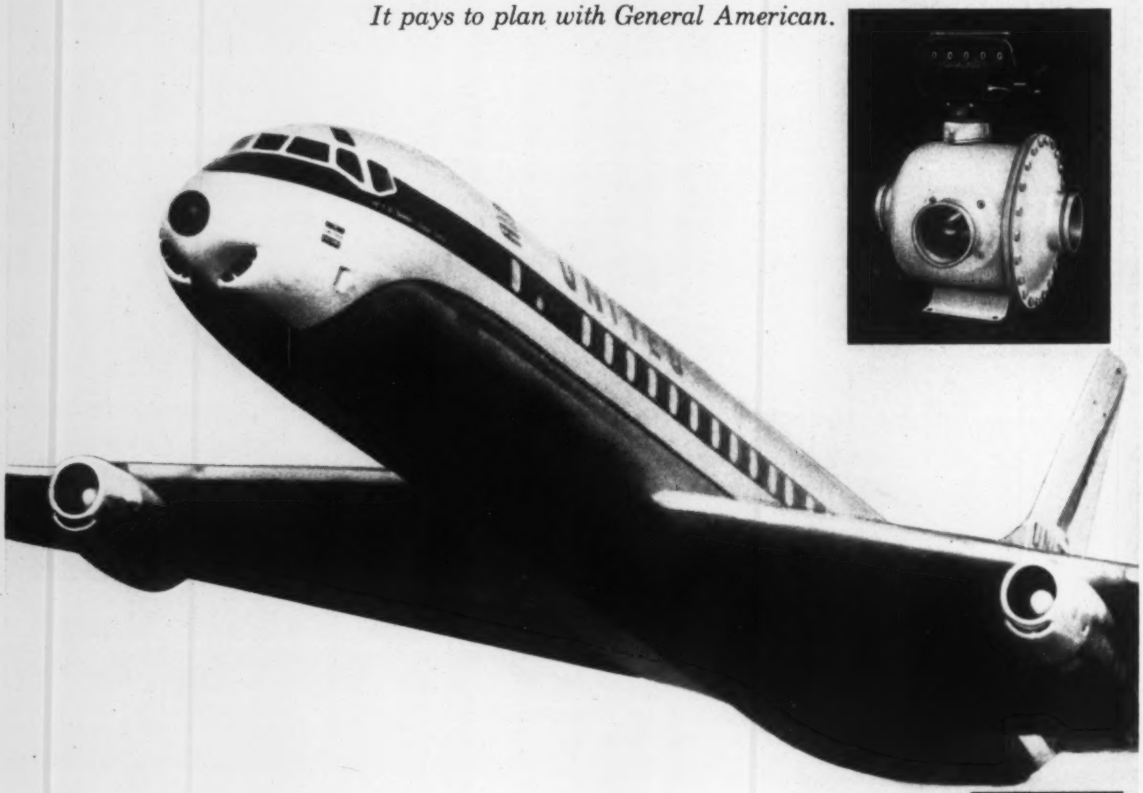
helps keep
jet aircraft where
the money is
...in the air

Big jet aircraft make money only when they are in the air. Every minute they are earthbound is costly. You just can't take chances on failure of aircraft engines from fuel contamination, or on failure of refueling equipment. That's why those parts of Brodie BiRotor refueling meters and control valves that come in contact with the fuel are chemically plated with KANIGEN nickel alloy.

Brodie BiRotor meters have been used for controlling aircraft refueling for many years, and their internal parts have been KANIGEN-coated ever since this highly accurate method of plating difficult or complicated surfaces was perfected.

Do you have a corrosion or contamination problem? Is it a small part like the Brodie meter housing? Or is it a surface as large as the inside of a 20,000 gallon tank car? Whatever it is, there's a way to solve your problems with KANIGEN chemical nickel plating. Write or phone the nearest General American office.

It pays to plan with General American.



KANIGEN DIVISION
GENERAL AMERICAN TRANSPORTATION CORPORATION
135 South LaSalle Street
Chicago 3, Illinois
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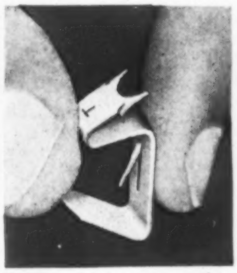
Another SPEED NUT Savings Story . . .

62% cost reduction made with **SPEED CLIPS**® on Cramer Posture Chairs



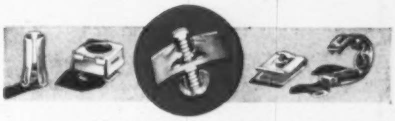
A dozen Speed Clips now do the job of fastening upholstery to the steel seat of Cramer Posture Chairs. Before the switch to Tinnerman Speed Clips, an expensive formed-steel rim was spot-welded to the seat to do this job.

Speed Clips save Cramer at least 46 cents—or 62% of fastening cost—on each chair . . . they eliminate the rim-forming and spot-welding operations . . . permit faster, easier assembly . . . simplify disassembly if the chair ever needs re-upholstering. Working jointly with Cramer's engineering staff, Tinnerman fastening specialists were able to provide all these advantages without sacrificing product quality.

Assembly costs on your product are likely to benefit greatly, too, if you'll enlist the aid of this Tinnerman team. You can arrange for a free Fastening Analysis of your product simply by calling in your nearby Tinnerman representative. You'll find him listed in the "Yellow Pages" and in Sweet's PD File under "Fasteners." Or write direct to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®



FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano Bundy GmbH, Heidelberg.

For more information, turn to Reader Service card, circle No. 456

OHIO RUBBER

"CUSTOMEERED COMPONENTS BASIC TO INDUSTRY"

STAINLESS STEEL JEWELS
make facsimiles by the million!

OHIO RUBBER can, and regularly does produce 100,000 *identical* rubber parts per day from one set of production tooling. The jewel-like precision of the self registering molds shown above—actual size—is a key factor in ORCO's high speed, high accuracy, continuous molding process.

AUTOMATIC INTEGRATION of processing steps which are usually handled separately eliminates variables—provides precise control for achieving the ultimate in product uniformity. RUBBER PARTS up to 1½" in diameter and 1" in thickness produced by this process are distinguished by uniformity, minimum flash and precision tolerance of ± .003".

QUANTITY REQUIREMENTS involving not less than 500,000 parts proves best for this new process.

"**DO YOU** use small precision molded rubber parts by the million?", if so, the full story of ORCO "CUSTOMEERED" Continuous Molding is yours via free Bulletin CM-100. Send for your copy today to see how custom molded, precision rubber parts can be produced in volume—at less cost. MP-160

ORCO

THE OHIO RUBBER COMPANY

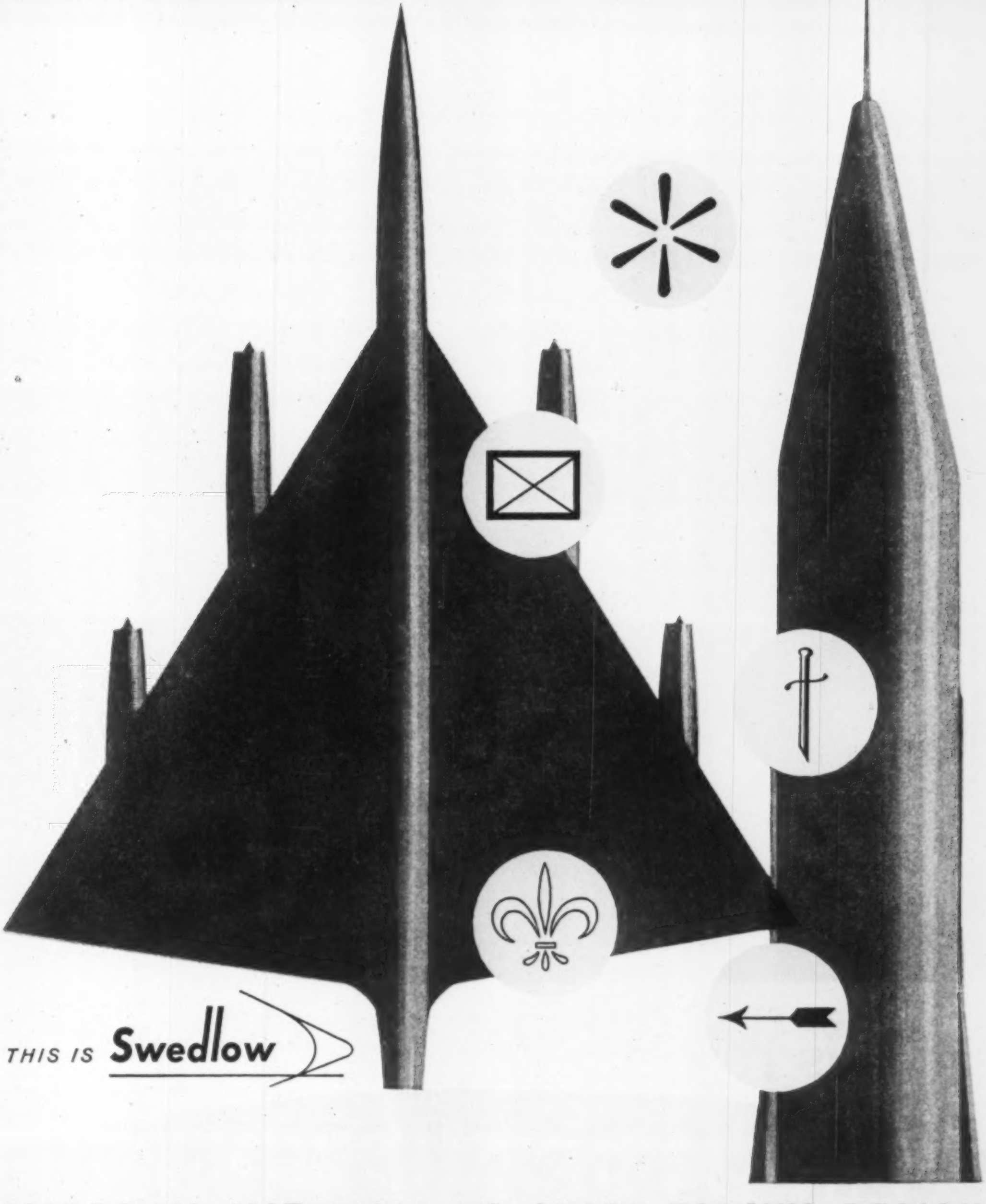
General Office • *WILLOUGHBY, OHIO* • WHitehall 2-0500

A DIVISION OF THE EAGLE PICHER COMPANY

EAGLE EP PICHER

▲ For more information, turn to Reader Service card, circle No. 418

For more information, circle No. 451 ▶



THIS IS **Swedlow**

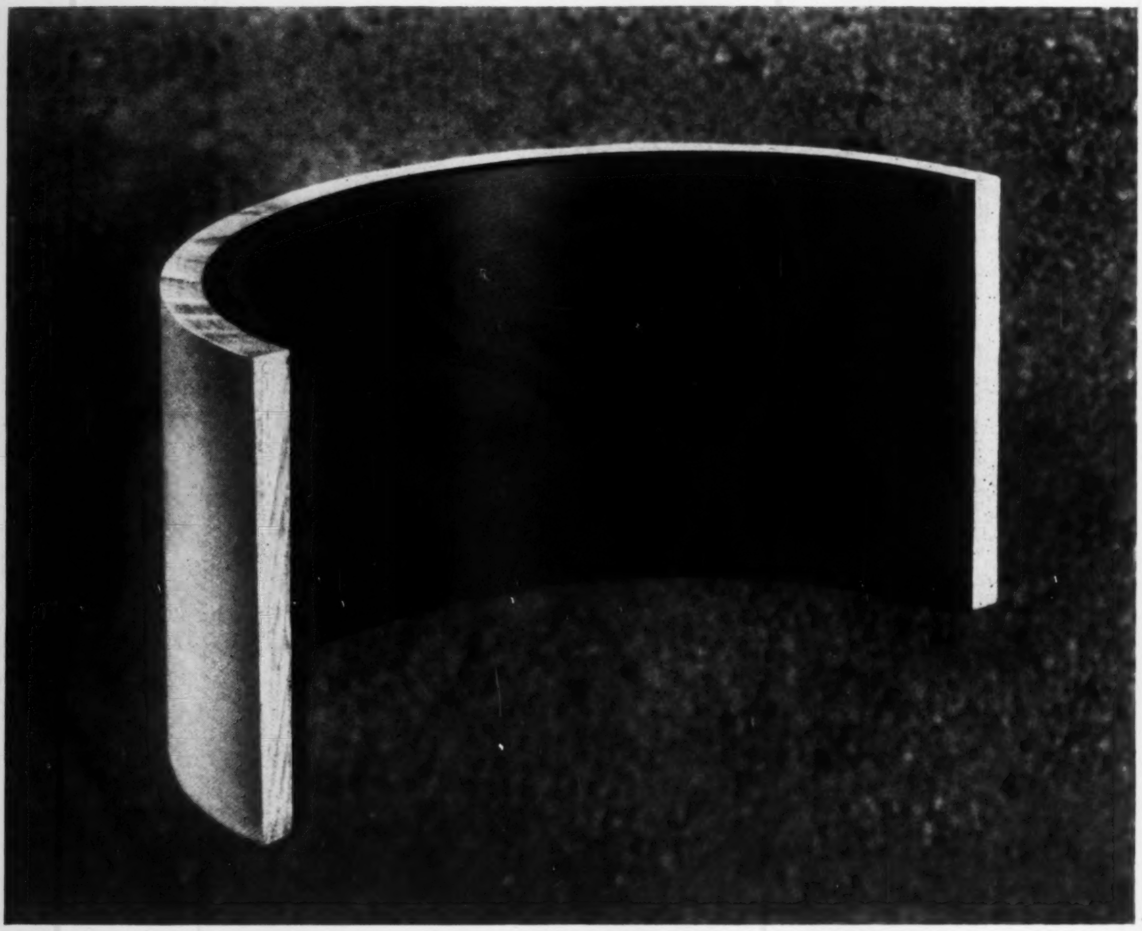
TOMORROW'S MATERIALS TO SHAPE TODAY'S DESIGNS

Confidence is a driving force on today's drawing boards. It is the engineer's confidence that the materials he demands can and will be created. Swedlow is unique in its ability to develop and produce materials to meet this demand. These Swedlow developments will help you shape today's designs for tomorrow's air and space vehicles.

✳ **Dyna-Therm D-65: flexible flame-resistant coating.** Intumescent coating may be painted on in the field. Promises less pad refurbishment time. It cures quickly, protects equipment against heat and blast, up to 6000° F. Remains flexible. Can be scraped away for recoating. ⊠ **High Temperature reinforced plastic parts and laminates.** Wide variety of combinations to meet exact needs. Flat sheets or compound shapes. Minimum weight and bulk. Heat resistant. For nose cones, exit cones, ducting, shielding. † **Metallized heat reflective laminates.** Gold and aluminum coatings increase radiant heat resistance to over 1650°F. Flat sheets or compound shapes. Light, strong; for radiant heat, heat shielding, exhaust heat damping. ⚜ **Reinforced plastics.** Continuous and press made sheets and molded parts to meet individual requirements. Applications include mechanical, electrical, electronic, phototemplate, decorative, aircraft cargo liners, and many others. ← **Plastic Glazing.** Stretched, as-cast, monolithic and laminated acrylic windows, canopies, windshields, with emphasis on high temperature glazing applications. Optically polished, tough, light weight, resistant to fracture.

WRITE for technical information specifying materials of your interest. Please refer to Dept. 18.

SWEDLOW Inc. / LOS ANGELES 22, CALIFORNIA / YOUNGSTOWN 9, OHIO



This revolutionary new bearing

NEVER NEEDS LUBRICATION!

. . . Made by St. Regis Panelyte—The St. Regis Panelyte Division has developed an amazing new bearing that actually runs without lubrication *and* with little or no wear! Made of a combination of plastic materials, this new bearing has outstanding strength and moisture resistance plus an extremely low friction co-efficient. This gives the new bearing two special advantages: 1) High resistance to wear (especially in applications of high loads and low speeds), and 2) High resistance to corrosion. Remember, both of these features are now possible *without* lubrication!

A leading eastern paper manufacturer says: *"After eight months of service on our #3 paper machine dryer, there are no visible signs of wear or deterioration on the pair of Panelyte bearings. On the basis of our tests, and their performance with no lubrication, I am recommending the installation of a complete set of these bearings on this machine."*

Get complete details on this revolutionary new "greaseless" bearing. Write today to Panelyte Division, Dept. ME-10, St. Regis Paper Company, 150 East 42nd Street, New York 17, N. Y.

PANELYTE DIVISION **St. Regis PAPER COMPANY**
150 EAST 42ND STREET NEW YORK 17, N. Y.

For more information, turn to Reader Service card, circle No. 440

New bearings made with TEFLON® last over five times as long as conventional bearings in kiln oven at 370°F.

A paper company's insulation board passes through a kiln oven (370°F.) on rollers supported by 2,000 saddle bearings. Material formerly used cost $2.10 per bearing. Average life: 1½ years. Failure of these bearings frequently caused damage to the steel stub shafts, which then had to be replaced or refinished. Additional cost: estimated at about $0.75 per shaft. Cost per year: well over $1.50 per bearing, plus the additional cost of labor and downtime.

After a thorough program of evaluation, bearings of a filled TEFLON TFE resin were installed. First cost: $3.25 per bearing. After two years of service, the new bearings are still performing perfectly and the shafts show no wear whatsoever. The paper company estimates the service life of the reinforced TEFLON bearings to be at least 10 years. Cost per year: less than $0.33 per bearing.

TEFLON TFE resins offer an exceptionally low coefficient of friction, virtually complete chemical inertness, high-temperature performance up to 500°F. Bearings of TEFLON are usually tailored for increased loads and velocities or high wear resistance by the use of reinforced constructions and filled compositions. And they make possible performance advantages and cost savings like those cited above.

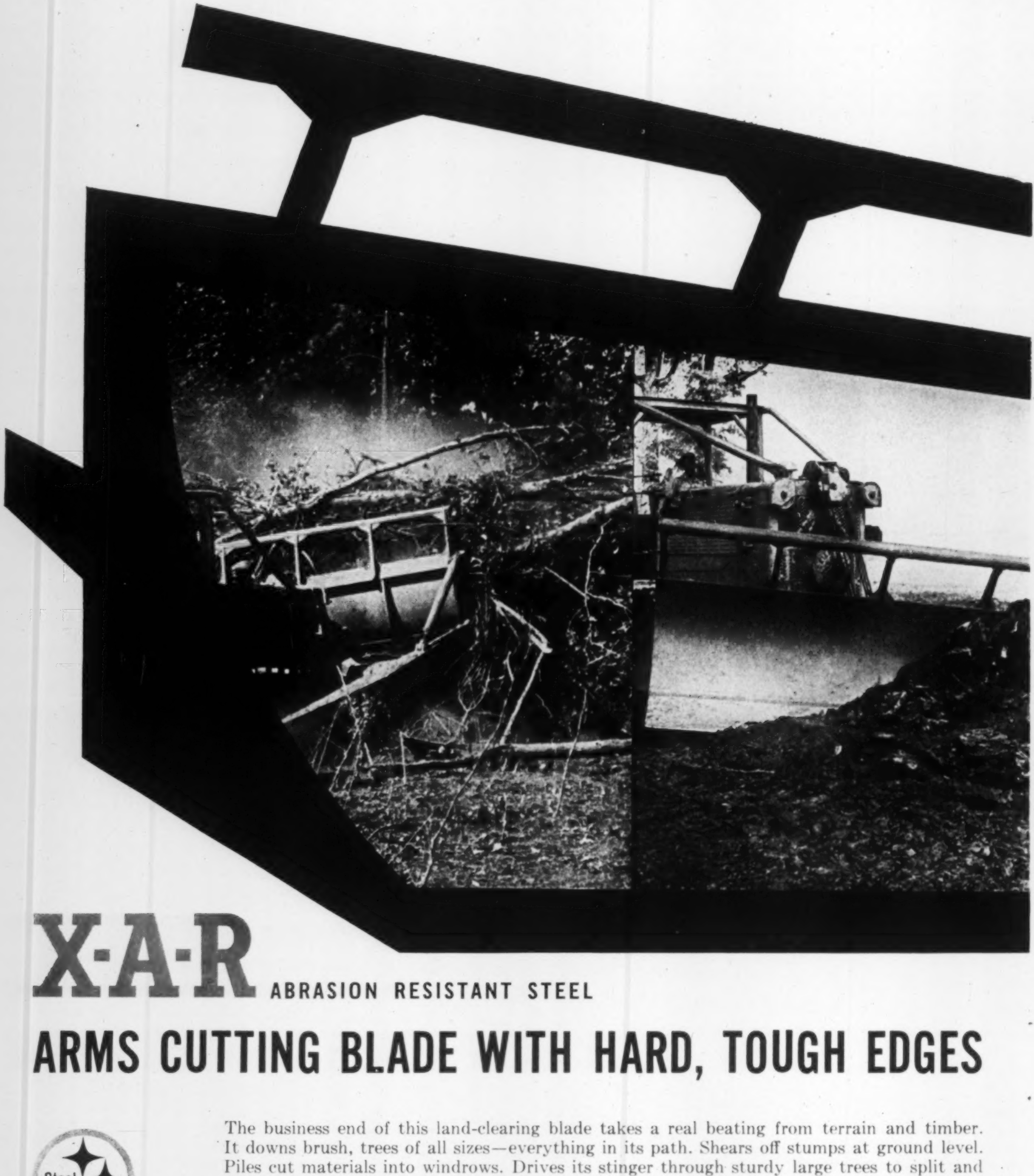
For further information and the new fact-filled booklet "Designing with TEFLON", write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, T26-10, Room 2526, Nemours Building, Wilmington 98, Del. *In Canada*: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

TEFLON®
FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resin.

For more information, turn to Reader Service card, circle No. 356



X-A-R ABRASION RESISTANT STEEL

ARMS CUTTING BLADE WITH HARD, TOUGH EDGES

Steel

Look for the STEELMARK on the products you buy; place it on the products you sell.

The business end of this land-clearing blade takes a real beating from terrain and timber. It downs brush, trees of all sizes—everything in its path. Shears off stumps at ground level. Piles cut materials into windrows. Drives its stinger through sturdy large trees to split and weaken them. Cuts a wide swath below ground level to build V-type drainage ditches. Works long, hard and fast. ◆ The point of it all? Edges made from $\frac{3}{4}$" and 1" X-A-R 15 with a hardness of 360 BHN. X-A-R is the name for tougher, harder alloy steels developed by Great Lakes Steel especially to meet abrasion problems. They're made to work better and last longer wherever materials collide with equipment—as liners, teeth, bars, blades, and plates for example. *Under conditions that commonly wear out equipment in a hurry, X-A-R*

Great Lakes Steel is a division of

X-A-R STEELS ARE AVAILABLE AT THESE STEEL SERVICE CENTERS

Benedict-Miller, Inc.
Lyndhurst, New Jersey

Joseph Demsey Co.
Cleveland, Ohio

Ducommun Metals & Supply Co.
Los Angeles, California

Interstate Steel Co.
Evanston, Illinois

Lockhart Iron & Steel Co.
Pittsburgh, Pennsylvania

Rome K/G Clearing Blades made of X-A-R—manufactured by Rome Plow Company, Cedartown, Georgia

FOR QUICK, ECONOMICAL LAND CLEARING

outwears any other type of steel. ◆ Close control during heat-treating, quenching and tempering is the secret of low carbon alloy X-A-R steels. And workability is as favorable as their hardness and toughness. Difficult problems, such as welding under cold conditions or extensive flame cutting, are handled well by X-A-R 30. For *extremely* difficult problems, choose X-A-R 15. ◆ X-A-R abrasion resistant steels, supplied in hardnesses from 360-400 BHN (or, by agreement, in lower Brinell hardnesses), are immediately available in 1/8″ to 1″ thicknesses, widths up to 72″ and lengths up to 35′. For complete technical information, write Great Lakes Steel Corporation.

X-A-R

ABRASION RESISTANT STEELS

A PRODUCT OF

GREAT LAKES STEEL

Detroit 29, Michigan

NATIONAL STEEL CORPORATION

Marsh Steel & Aluminum Co.
Kansas City, Missouri

O'Neal Steel, Inc.
Birmingham, Alabama

Salt Lake Hardware Co.
Salt Lake City, Utah

A. C. Leslie & Company, Ltd.
Montreal, Canada

For more information, turn to Reader Service card, circle No. 377

IN BLOW-MOLDING

Hi-fax® Sets the Standard Other Materials Strive to Match

TODAY

Hi-fax, high-density polyethylene, was the pioneer plastic in thin-wall, blown containers. Hi-fax set the standard . . . was the first material approved by both producers and users of plastic containers for light-duty liquid detergents. While other materials seek to match the Hi-fax standard, Hi-fax remains universally in demand in this first major market for blow-molded high-density polyethylene products.

The same physical and processing properties which enabled Hi-fax to pioneer the breakthrough in detergent bottles have proved equally useful in household chemical, drug and cosmetic containers, and in the development and production of industrial packages of increasingly larger size and scope.

As blow-molding horizons broaden, Hi-fax will continue to lead the way . . . in product testing, market development, and continuous research designed to improve the properties and performance of today's finest blow-molding material.

TAILORMADE FOR TOUGH JOBS

These nesting Hi-fax bottles carry the water supply for a housetrailer; they were custom-blown to fit available space in trailer interior.

BIG FAVORITE WITH BIG BRAND NAMES

Hi-fax blown containers are now used by all of the major manufacturers of light-duty liquid detergents.

FOUR VARIATIONS ON A THEME

Avon uses the same Hi-fax container to package both liquid and dry products in its new line of children's cosmetics.

For more information, turn to Reader Service card, circle No. 477

HI-FAX LEADS THE WAY

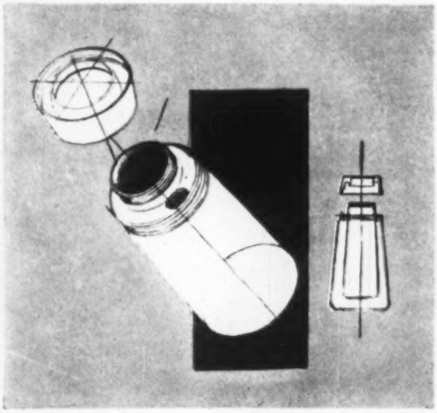
The larger the part—the greater the need for Hi-fax

TOMORROW

Growing faster than any other sector of the plastics industry, blow-molding now reaches out into many new markets: industrial packaging, sporting goods, toys, furniture, lighting, and automotive and marine parts. Parts grow larger as improved equipment and processing techniques keep pace with new demands. And still leading the way is Hi-fax, for the larger the part, the greater the need for Hi-fax in terms of superior physical properties and ease of processing.

Hi-fax leads the way, too, in new market developments. Hercules blow-molding experts are ready to help you with design and product planning, in order that you may achieve maximum economies in material and production costs.

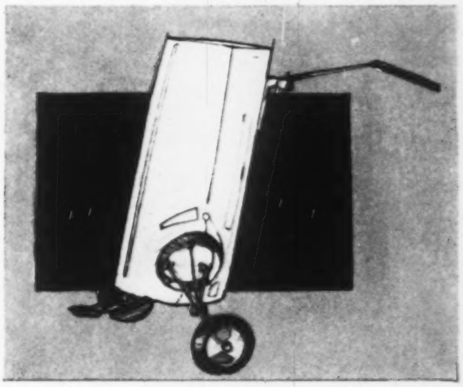
Here's a preview of some of the brand new product ideas now possible with Hi-fax and blow-molding:



INDUSTRIAL PACKAGING:

Double-wall bottle solves the packaging problem which arises when two separate ingredients in a product must be shipped separately for mixing immediately prior to use. Blow-molded with Hi-fax, this combination bottle would have the all-important stress-crack resistance so necessary when corrosive products are involved.

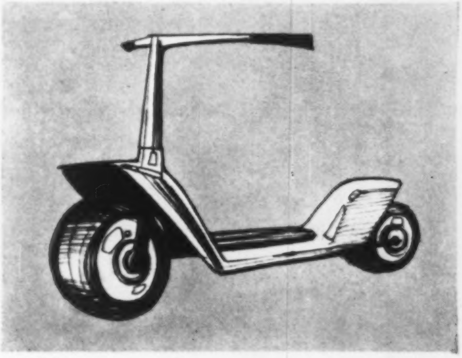
ORIGINAL DESIGNS BY SUNDBERG-FERAR, DETROIT, MICH.



SPORTING GOODS:

This ingenious design for a golf cart combines bag and wheeled-carrier in a single, compact, lightweight unit which can be readily blow-molded with Hi-fax.

Wheels (and tires, if desired) could be blown parts, too. Complete unit would be highly functional, less tiring to use, weather-resistant, and significantly lower in cost.



TOYS:

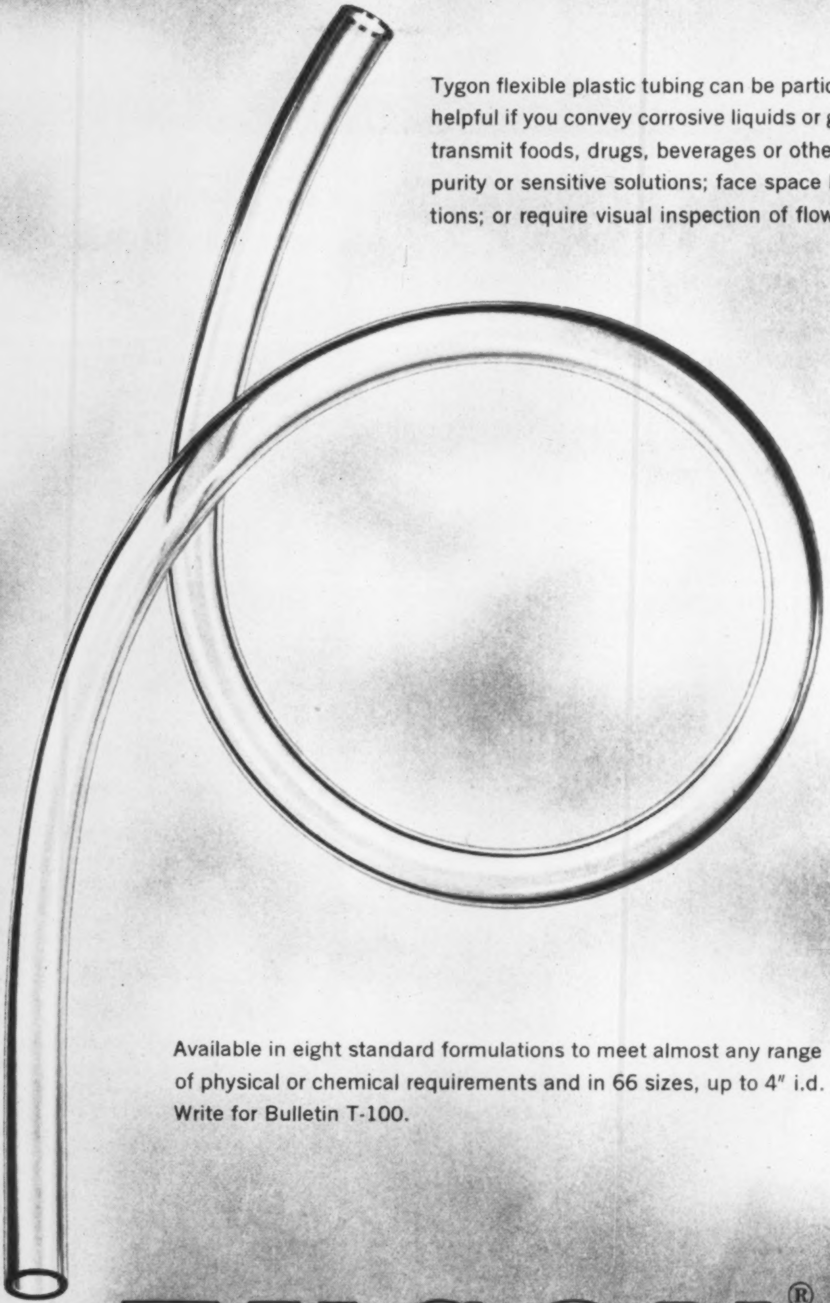
Tough, but handsome, too, blow-molded Hi-fax has just what it takes for the design of such modern-styled outdoor toys as this. Both body and wheels could be blown with Hi-fax, resulting in a unit that would be less than half the weight of a metal counterpart, with a finish that would not dent, chip off, rust or corrode.

HERCULES

HERCULES POWDER COMPANY
INCORPORATED
Hercules Tower, 910 Market Street, Wilmington 99, Delaware
THREE NEW MATERIALS FOR THE PLASTIC INDUSTRY

HI-FAX® HIGH-DENSITY POLYETHYLENE • PRO-FAX® POLYPROPYLENE • PENTON® CHLORINATED POLYETHER

CP60-15



Tygon flexible plastic tubing can be particularly helpful if you convey corrosive liquids or gases; transmit foods, drugs, beverages or other high purity or sensitive solutions; face space limitations; or require visual inspection of flow.

Available in eight standard formulations to meet almost any range of physical or chemical requirements and in 66 sizes, up to 4" i.d. Write for Bulletin T-100.

TYGON®

A PRODUCT OF THE U.S. STONEWARE CO., AKRON 9, OHIO

264-G

▲ For more information, turn to Reader Service card, circle No. 459

For more information, circle No. 462 ➤

LOWER YOUR FINISHING COSTS with

WALLINGFORD

Bright Annealed Stainless Steel Strip

Conventional steel making is inadequate when you require decorative stainless steel strip with an extra bright finish to pass rigid corrosion tests. "Bright Annealing" is the answer – and Wallingford is the first steel maker to apply this process to its regular production of stainless strip!

How does "Bright Annealing" lower finishing costs? By preventing formation of oxide scales present after conventional annealing and by eliminating the need for further processing which often dulls the finish. Preservation of the bright surface produced by highly polished rolls results in a finish so excellent that users find that buffing time is greatly reduced, affording significant savings.

Superiority in facilities, research and skill enables Wallingford to produce "tonnage on a laboratory basis" and make quality strip available economically.

SEE NEXT PAGE FOR MORE INFORMATION ON BRIGHT ANNEALED STAINLESS STEELS

THE WALLINGFORD STEEL CO.
WALLINGFORD, CONNECTICUT, U.S.A.

COLD ROLLED STRIP: Super Metals, Stainless, Alloy
WELDED TUBES AND PIPE: Super Metals, Stainless, Alloy

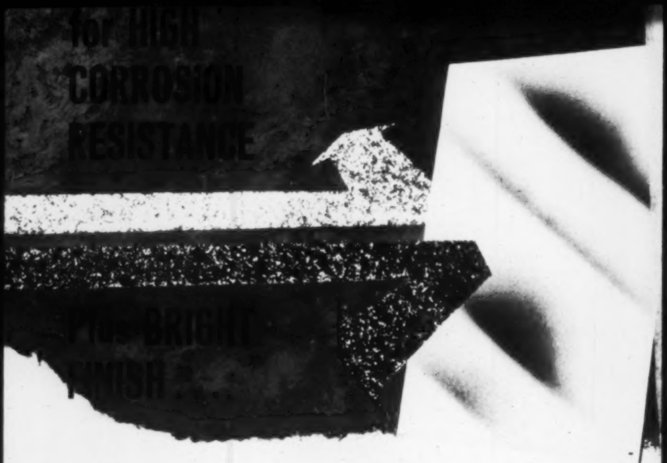
COMPLETE AND MAIL REPLY POST CARD TO RECEIVE YOUR COPY OF OUR NEW FOLDER ON STAINLESS STEEL STRIP, "TONNAGE ON A LABORATORY BASIS"

☐ Please send me your "Tonnage On A Laboratory Basis" Folder (Form No. G-1333).

☐ Have your representative call to discuss my finishing requirements.

Name__________ Title__________
Firm__________
Street__________
City__________ Zone_____ State_____

JUST COMPLETE ABOVE AND MAIL –
NO ADDRESSING OR POSTAGE REQUIRED.



WALLINGFORD

Bright Annealed Stainless Steel Strip

Stainless steel derives its resistance to corrosion from the presence of chromium, so any depletion of chromium during processing must be avoided.

Because of Wallingford's success in this area, Wallingford Stainless Steel passes even the most rigid corrosion tests set up by leading manufacturers. Exceptional corrosion resistance is of prime importance when the stainless steel is to be used for decorative purposes and may be exposed to weather, salt water, or other corrosive elements.

In producing this stainless steel strip, Wallingford employs bright annealing. Result? Reduced customer buffing costs PLUS corrosion resistance and a bright finish never before attained!

Whether your problem is brightness of finish or the degree of corrosion resistance, Wallingford can supply stainless steel strip that will satisfy.

Widths from 0.150" to 27". Thicknesses down to .0005". Extremely close tolerances are maintained.

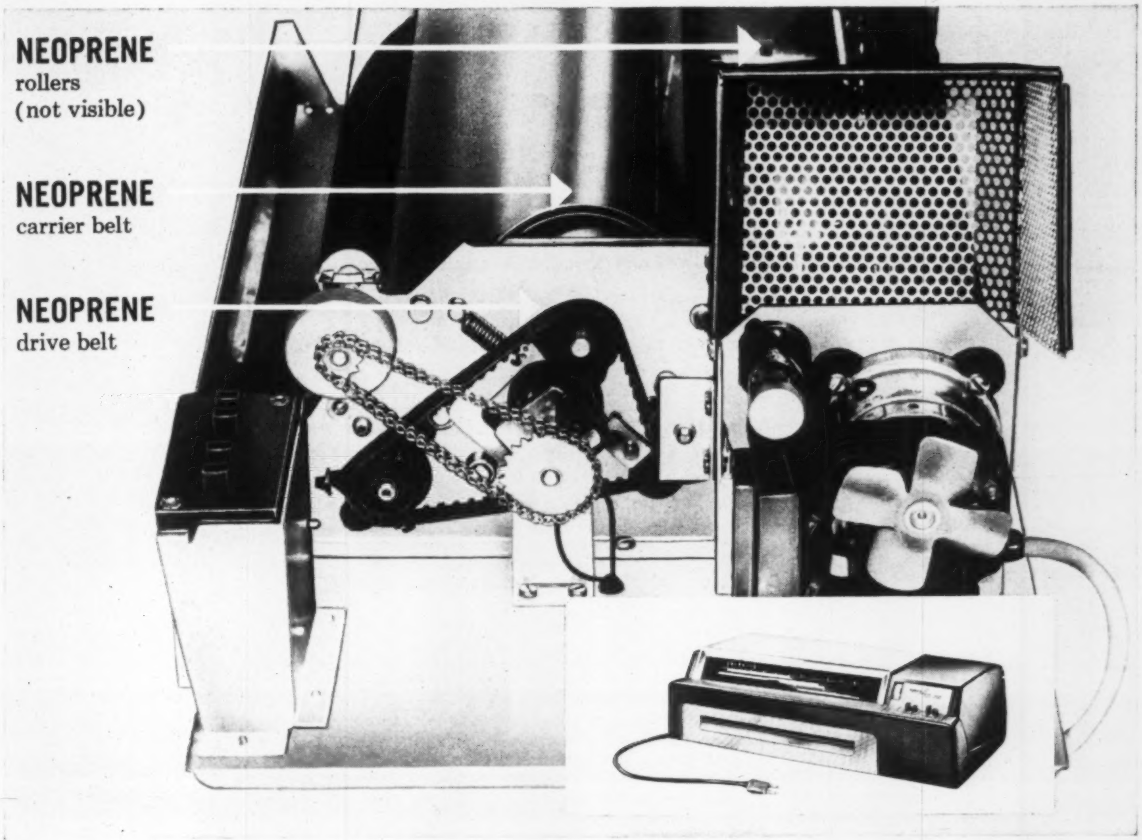
COMPLETE REVERSE SIDE OF REPLY CARD BELOW AND MAIL TO RECEIVE NEW STAINLESS STEEL STRIP FOLDER, "TONNAGE ON A LABORATORY BASIS"

FIRST CLASS
PERMIT NO. 116
Wallingford, Conn.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States
— POSTAGE WILL BE PAID BY —

THE WALLINGFORD STEEL CO.
Wallingford, Connecticut

MDE



In new photocopier...

NEOPRENE PARTS GIVE "BEST ALL-AROUND PERFORMANCE"

In designing the new "Auto Stat" photocopy machine, engineers at the American Photocopy Equipment Company, Evanston, Illinois, specified neoprene *exclusively* where rubber parts were required. Included are such key components as: printer belt, carrier belt, drive belt, processor rolls and paper transport rolls.

"Neoprene gave us the best all-around performance of any material we tested," reports an Apeco engineer. "We found, for example, that it's highly resistant to the corrosive action of caustic developer chemicals. It withstands ozone exposure without cracking or crazing. In rollers and wheels, neoprene resists compression set, and in belting it holds its size and shape."

No other general purpose rubber can equal neoprene's *balanced combination* of properties, or match its resistance to so many deteriorating factors. Neoprene assures longer service life for equipment because parts *stay* lively and resilient over years of operation. What's more, parts made of neoprene will not support combustion.

If you'd like to learn more about the many ways neoprene is solving design problems in everything from household appliances to equipment for business and industry, write for a free copy of "An Engineering Guide to the Du Pont Elastomers." E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department MDE-10, Wilmington 98, Delaware.

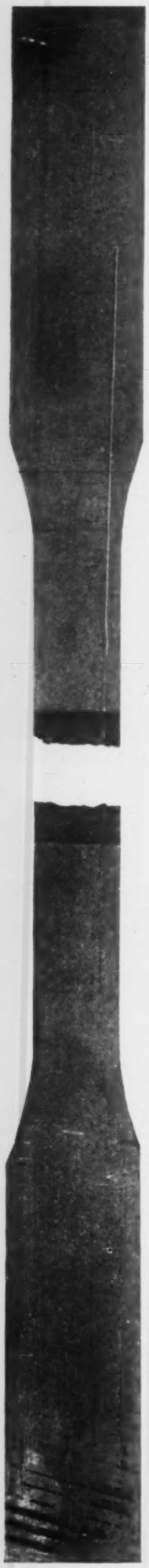
DU PONT
REG. U. S. PAT. OFF.

SYNTHETIC RUBBER
NEOPRENE HYPALON® VITON® ADIPRENE®

Better Things for Better Living . . . *through Chemistry*

◀ For more information, circle No. 462

▲ For more information, turn to Reader Service card, circle No. 354



Weld failures cut 89% using vacuum-melted filler wire

[Weld tests on alloy steel wire used in missile applications revealed nine times as many failures with air-melted wire as with Cannon-Muskegon vacuum-melted wire.] [Superior to consumable-electrode melting, Cannon-Muskegon vacuum-induction melting greatly reduces gas levels (nitrogen less than 25 ppm, oxygen less than 25 ppm, hydrogen less than 5 ppm). Combined sulphur and phosphorus run less than .015%.]

[These remarkably low gas and impurity levels can be most efficiently obtained with Cannon-Muskegon vacuum-induction melting. You are invited to write Cannon-Muskegon for further details.]

☛ Among test samples prepared from air-melted wire, 18 out of 32 failed at the weld.]

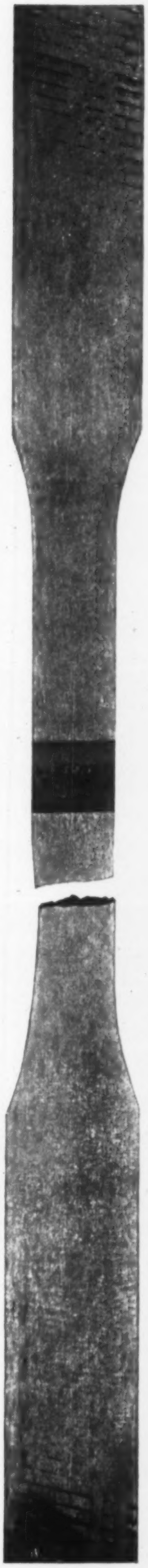
☛ Among similar samples prepared from the vacuum-melted wire of the same grade, only two out of 32 bars failed at the weld.]

[Different alloys of Cannon-Muskegon vacuum-melted welding wire are available in sizes from 1/32" to 1/8", in 36" cut lengths, or in 10 or 25-lb. spools packed in airtight Argon-filled steel containers.]

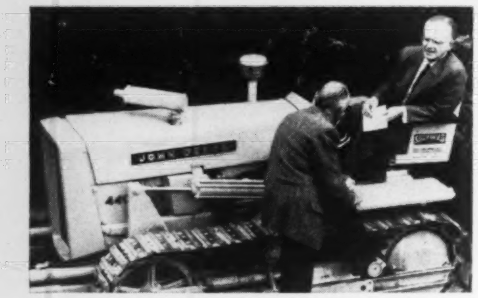
ULTRAMET
VACUUM ALLOYS

CANNON-MUSKEGON CORPORATION
Metallurgical Specialists • 2873 Lincoln Street • Muskegon, Michigan

For more information, turn to Reader Service card, circle No. 339



Henry Dreyfuss: man in a hurry



Dreyfuss talks design

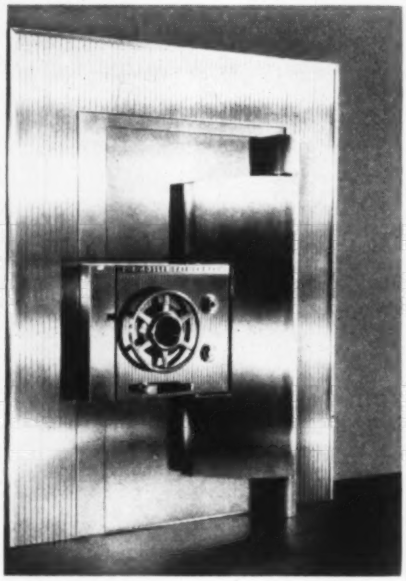
If you could get Henry Dreyfuss to sit still long enough for a caricature, the drawing would inevitably show him with his coat half on and briefcase in hand. Most likely, he would be on his way to the airport. He's on the East Coast a third of his time, on the West Coast a third, and the other third in between.

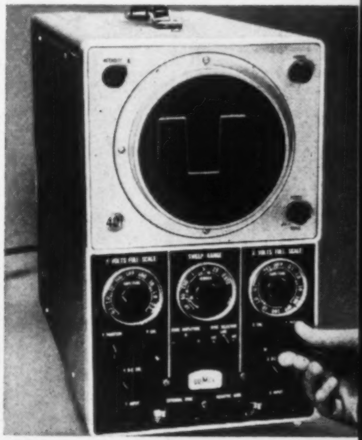
Henry Dreyfuss has been busy ever since he gave up scenery design in the late Twenties and helped pioneer the business that is now called industrial design. In the early days, he gave a new look to everything from hinges to pianos, cigarette lighters to tractors. Today he can look back on a career of redesigning vacuum cleaners and gas stations, bowling alleys and ship interiors, typewriters and dental equipment, magazine formats and military strategy rooms, plumbing fixtures and the Nike missile launcher.

But Henry Dreyfuss is not one to look back. There are designs on his boards today that will influence our lives twenty years from now. "Time," he says, "is one of the designer's big problems. A design assignment is often three years in development. The item may not be on the market for another three to ten years. After it's introduced it will be in use for any number of years. In order to design that far ahead, our ideas have to be fresh, advanced and sprightly. It is a challenge to have to think as far ahead as we do."

One thing that goes a long way is the Henry Dreyfuss design credo, and it is all about people. "It says in effect," Dreyfuss states, "that the item is going to be ridden in, sat on, looked at, talked into, operated or in some way used by people. If the point of contact between the product and people causes friction, we have failed.

"On the other hand, if people are made safer, more comfortable, more eager to purchase, more efficient, or





just plain happier—we have succeeded." And succeed Dreyfuss does, by following this yardstick for effective industrial design: 1. Safety and convenience of use. 2. Ease of maintenance. 3. Cost, including tooling, production and distribution. 4. Sales appeal. 5. Appearance.

Selection of the right material for the job plays an important role in satisfying each of the five requirements. As a matter of ethics and sheer common sense, Henry Dreyfuss, like any member of the American Society of Industrial Designers, will not endorse any one material. "We have worked with all materials. What we want is the material that is right for the job. We look for the material that combines reasonable cost with the ability to be fabricated economically, and at the same time will give the product the built-in quality and durability it needs to sell well." With no-nonsense requirements like that, it is not surprising that a great many Dreyfuss-designed products use steel in one way or another.

Steel has strength, integrity and honesty. Steel is what the designer is apt to call a 'natural.' Dreyfuss feels that the public's image of steel depends largely on the product itself. A massive steel vault door conjures up an image of strength, imperviousness. Stainless Steel tableware suggests style and modernity. Steel curtain wall panels give buildings the look of tomorrow.

The moral is this: steel has been with us for ages, yet it is the modern metal, the metal of the future. Its enduring modernity will continue to be recognized, and used, by designers like Henry Dreyfuss.

(turn the page for a new look at steel)

USS **United States Steel**

TRADEMARK

designing with USS High Strength Steels

Good design goes beyond material selection. Once the choice has been made, the designer's job is to take full advantage of the material's properties. Few materials offer designers as much opportunity as high strength steels.

COR-TEN Steel was developed by U.S. Steel and first used in 1933.

Dead weight in stationary structures is costly; in mobile equipment dead weight requires more power to move.

USS Cor-Ten Steel is a name that has become a byword in design circles. It is a time-tested, high-strength low-alloy steel. Structural designers welcomed Cor-Ten Steel because it allowed them to pare dead weight and to lower maintenance costs. As structures, mobile equipment and machinery got bigger and bigger, dead weight became more of a problem. Even when weight could be shaved without stress problems, durability suffered. This high strength steel answered both problems.

USS High Strength Steels' yield points are all 50,000 psi min. compared to 33,000 psi for structural carbon steel.

Strength did it. Cor-Ten brand and other USS High Strength Steels have a 50% higher yield point than structural carbon steel. They permit as much as 33% weight reduction. They have superior resistance to atmospheric corrosion and abrasion, so there is little reason to overdesign. Their fatigue and impact properties are excellent. Here is a quick look at three well-known USS High Strength Steels:

Send for the manual described at the right for a comprehensive guide on how to design with high strength steels.

USS Cor-Ten Steel has a yield point 50% greater than structural carbon steel, has four to six times its resistance to atmospheric corrosion. It is used to do any one of these three things: 1) in slimmer sections to cut weight at no strength loss; 2) in equal sections to increase load-carrying capacity, cut maintenance and lengthen life; and 3) any number of combinations of 1 and 2. Cor-Ten Steel also has greatly superior paint adherence and is used where a longer interval between repainting is wanted.

USS Tri-Ten Steel, with its 50% higher yield point than structural carbon steel, has superior notch toughness at low temperatures and keeps rugged equipment operating even in sub-zero weather. Its high endurance limit makes Tri-Ten Steel ideal for mobile equipment that must take repeated loading and reversals of stress. It is a natural for welded structures and bridges.

MAN-TEN Steel costs only about 20% more than structural carbon steel; TRI-TEN Steel about 36% more, and COR-TEN Steel 42% more.

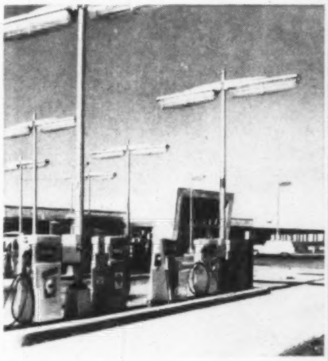
USS Man-Ten Steel also has a 50% higher yield point than structural carbon steel, and is the low-cost member of the family. Weight reduction as little as 17% with Man-Ten Steel will save money on material cost alone. Man-Ten Steel is a tough, durable steel and widely used in earthmoving equipment, truck frames, material handling apparatus and riveted bridges.

High strength steels represent but a few of the over 3000 grades of steel in existence today. United States Steel makes a complete line of high strength steels, as well as constructional alloy, stainless and carbon steels. Bring your design problems to us. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS, COR-TEN, MAN-TEN and TRI-TEN are registered trademarks.

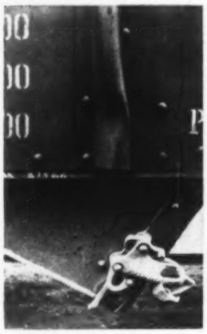
USS United States Steel

Cranes have to operate in all-weather temperatures and are subject to stress and shock. That's why many of them are made of tough **TRI-TEN** Steel.



Light standards stay good looking for years because of **COR-TEN** Steel's outstanding atmospheric corrosion resistance. Paint life is extended. Slim design is made possible by **COR-TEN** Steel's strength.

TRI-TEN Steel has cut weight and cost of dozens of major bridges. In the bridge shown here, **TRI-TEN** Steel saved a quarter of a million dollars.



One of the first applications of **COR-TEN** Steel was in hopper cars for weight reduction and longer life. Today, use of **COR-TEN** Steel can save hundreds of dollars over the life of a car.

MAN-TEN Steel, used in truck frames and body members, reduces dead weight and increases payload.

The LPG cylinder business uses considerable amounts of **MAN-TEN** Steel because of its strength, cost and ease of fabrication to lighten the weight.

This mark tells you a product is made of modern, dependable Steel.

Here's a book that is in the hands of thousands of engineers and designers. It is your guide to the design of lighter, stronger equipment and structures.

design manual for high strength steels

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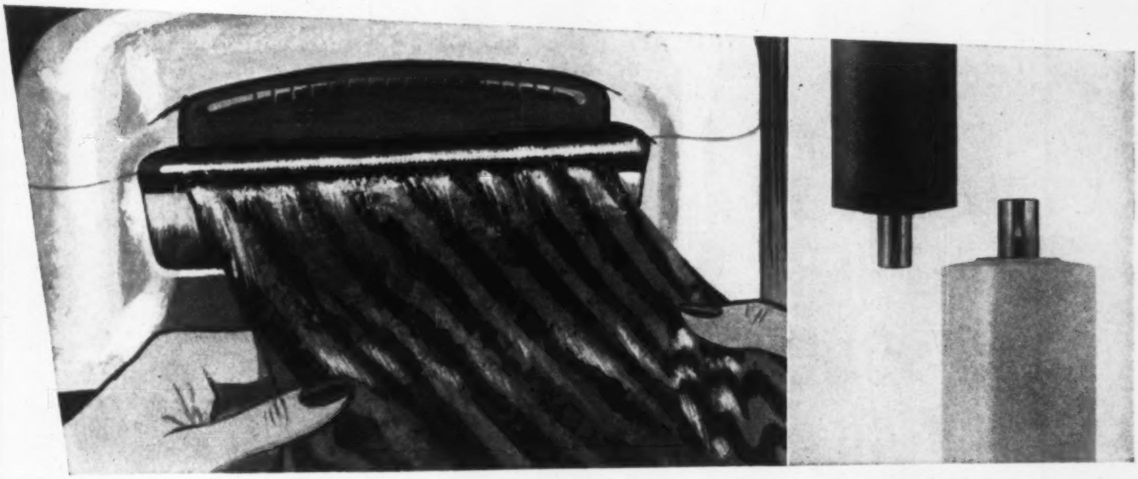

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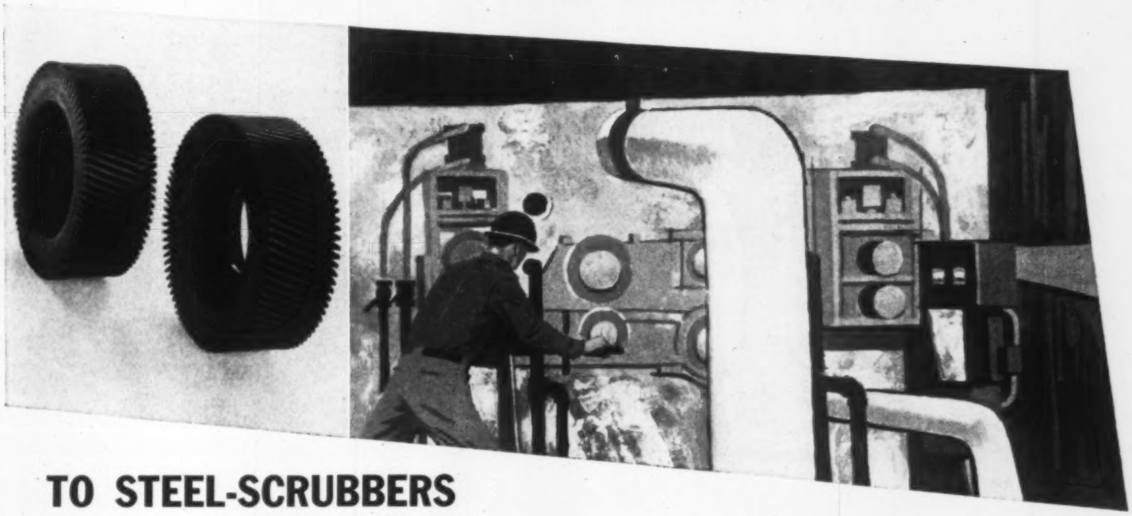

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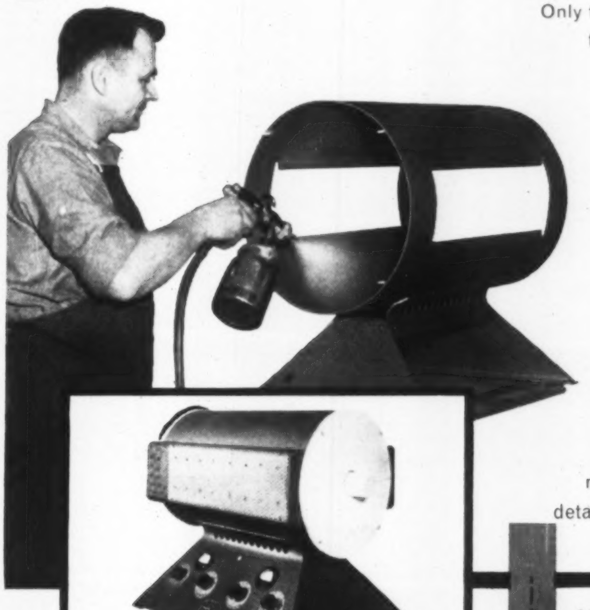

Only the finest kind of heat resistant finish satisfies engineers of the Hevi-Duty Electric Company, Milwaukee. The Hevi-Duty Combustion Tube Furnace shown here handles very high temperatures. The sheet steel furnace shell is protected *both on the inside and outside* by SICON in an attractive metallic green, capable of withstanding surface temperatures approaching the 1000°F. range. The inside application prevents rust from forming due to condensation which forms when furnace is initially started. While actual heat loss is minimal, due to highly efficient insulating brick, and by asbestos ends, Hevi-Duty knows from extensive experience that SICON will hold its original color indefinitely, will not chip, peel or powder under actual service use. This marked ability of Sicon to retain its film integrity and color under sustained heat, has made it preferred for scores of other products—manifolds, space heaters, incinerators, even missiles. Send details of your heat problems or fill out and mail coupon today.

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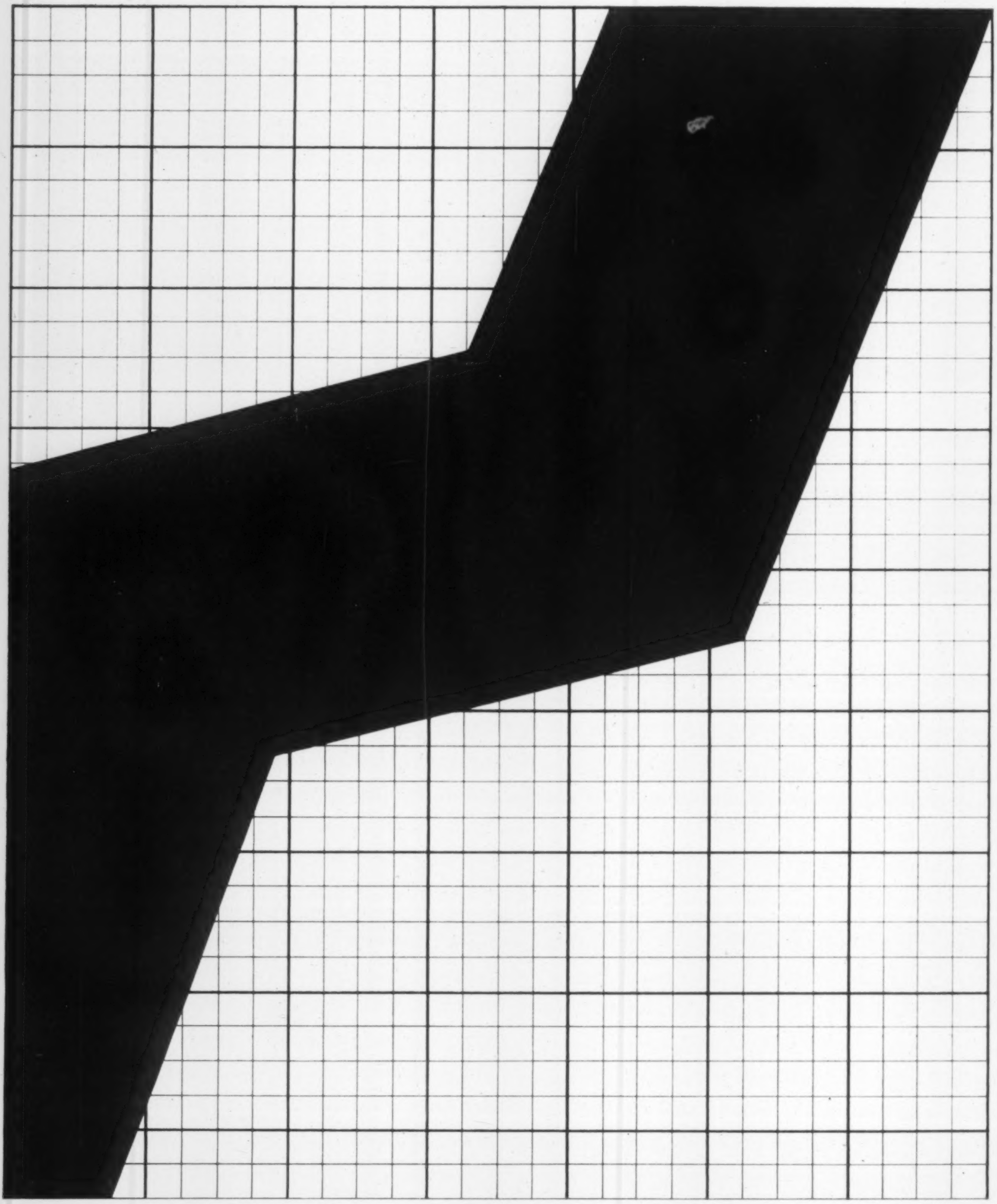
Ameripol Micro-Black sales climb

Here's why . . .



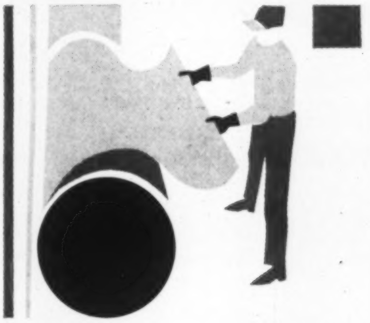
more than 1400% in just 18 months

Users report 21 ways to improve rubber products, save time and money with Ameripol Micro-Black masterbatch

A little over two years ago, Goodrich-Gulf introduced a black masterbatch that was destined to revolutionize rubber processing. This product was Ameripol Micro-Black. And, it set a new standard in carbon black dispersion, made possible by an exclusive process—high liquid-shear agitation of latex and carbon black slurry.

Micro-Black was tested by processors in a wide variety of product fields. And they came back for more. Proof: in the last 18 months alone—Ameripol Micro-Black sales are up 1400 per cent!

Now, here are the 21 ways Micro-Black has proven its ability to improve rubber products and save time and money:

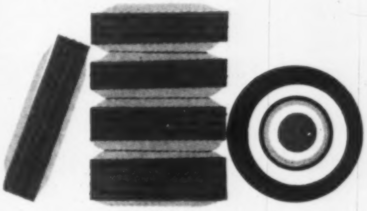


IN PRODUCTION, Ameripol Micro-Black . . .

1. Eliminates one weighing operation.
2. Eliminates one milling operation.
3. Shortens other mixing operations.
4. Releases mixing equipment for other uses.
5. Lowers power consumption.

IN STORAGE AND HANDLING, Ameripol Micro-Black . . .

6. Is packaged in thirty-bale units for faster handling.
7. Does not cold flow.
8. Permits stocking a semi-processed material.
9. Is easy to warehouse.
10. Eliminates in-plant storage of carbon black.
11. Ends carbon black mess and clean-up expense.
12. Is readily available from two strategic shipping points.



IN THE END PRODUCT, Ameripol Micro-Black . . .

13. Assures thorough dispersion of carbon black in the rubber.
14. Provides a uniform standard of quality control.
15. Reduces the number of rejects.
16. Adds substantially to abrasion resistance.
17. Prevents damage to rubber as caused by high-viscosity milling.
18. Provides a stronger bond between rubber and carbon black.
19. Permits performance advantages to be added at no increase in cost.
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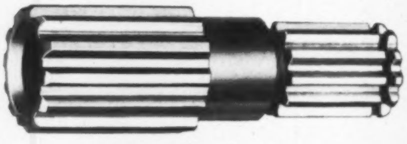

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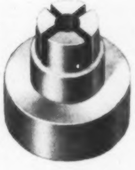
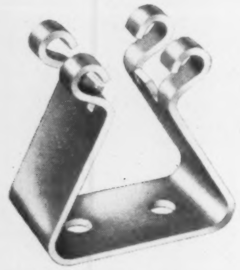
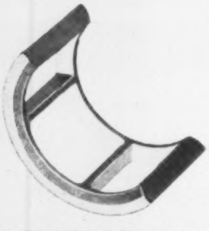


Non-Magnetic

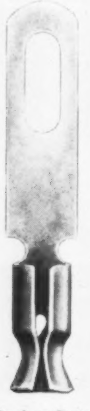
Good Conductivity



Wide Operating
Temperature Range



Excellent Wear Resistance
and Hardness



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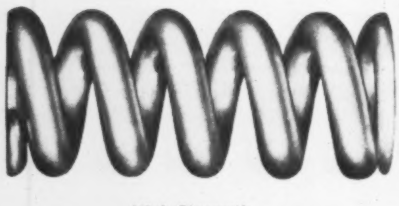

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Resistance to Anelastic Behavior

High Fatigue Strength

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ENGINEERING & DESIGN

...AT A GLANCE

Copper-containing steels have better fatigue properties when heat treated to high tensile strengths than similar steels without copper. Studies show that the amount of copper used is critical, with 1.3% by weight giving optimum strength when low tempering temperatures are used.

Source: National Bureau of Standards, Dept. of Commerce, Washington 25, D.C.

Improved methods for evaluating the properties of materials under conditions of extreme heat and cold are promised with the development of two new devices. One device is a special type of refrigerator that is said to permit the accurate measurement of tensile strengths at temperatures near absolute zero. The other device is an electric arc heater that is capable of supplying a stream of gas at temperatures as high as 20,000 F and at pressures as high as 15,000 psi—duplicating the extreme conditions met by space vehicles upon re-entry into the earth's atmosphere.

Sources: Arthur D. Little, Inc., Acorn Park, Cambridge 40, Mass. (refrigerator), and Westinghouse Electric Corp., Box 2278, Pittsburgh 30 (heater).

It may be more economical to paint thermoplastic parts that have been molded in neutral colored or reprocessed plastics rather than mold in color. A recent producer's study shows that this is especially true in applications where small quantities of materials and special colors are involved. A good paint to use is butyrate-acrylic.

Source: T. E. Hayden, Bee Chemical Co., 12933 S. Stony Island Ave., Chicago 33.

Inconel is an excellent construction material for the steam generating system of pressurized water nuclear power plants, a recent study shows. In the application, Inconel is exposed on one side to primary reactor water (i.e., water flowing past radioactive fuel elements) and on the other side to secondary boiler water.

Source: W. E. Berry, Battelle Memorial Inst., Corrosion Research Div., 505 King Ave., Columbus 1, Ohio.

A good way to find defects in electroplates and other coatings is electrographic printing: it provides accurate and permanent images of any defect, and permits prompt comparisons with existing visual records. The coated side of a specimen is placed against photographic paper and an electrical charge applied. Cations from the basis metal pass through any cracks or pores in the coating and form an image of the defect on the photographic paper.

Source: H. R. Miller and E. B. Friedl, Battelle Memorial Inst., 505 King Ave., Columbus 1, Ohio.

Polystyrene is the best material to use in optical systems exposed to intense gamma radiation or x-rays, according to recent research. Tests show that commercial-grade glass, and acrylic, allyl carbonate and polyvinyl acetate plastics have losses in light transmittance and are discolored after exposure to intense x-rays.

Source: Rpt. PB 145013, Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D.C.

A transparent oxide film may solve the age-old tarnishing problem associated with copper. Recent research shows that it may be possible to produce a protective oxide film by heating copper in atmospheres that are oxidizing to minor alloying elements and reducing to copper.

Source: C. H. Moore, Copper Products Development Assn., Inc., 50 W. Gay St., Columbus 15, Ohio.

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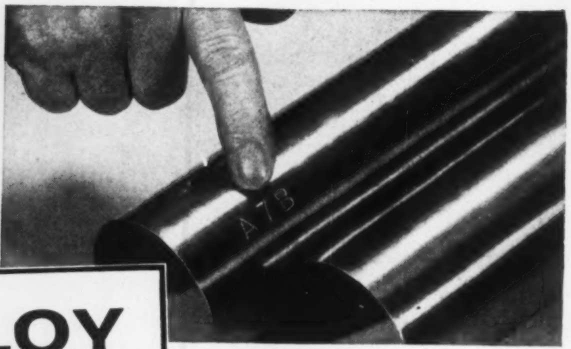

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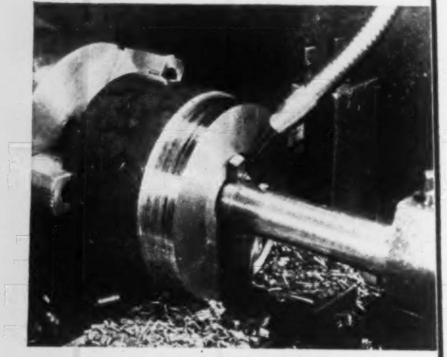

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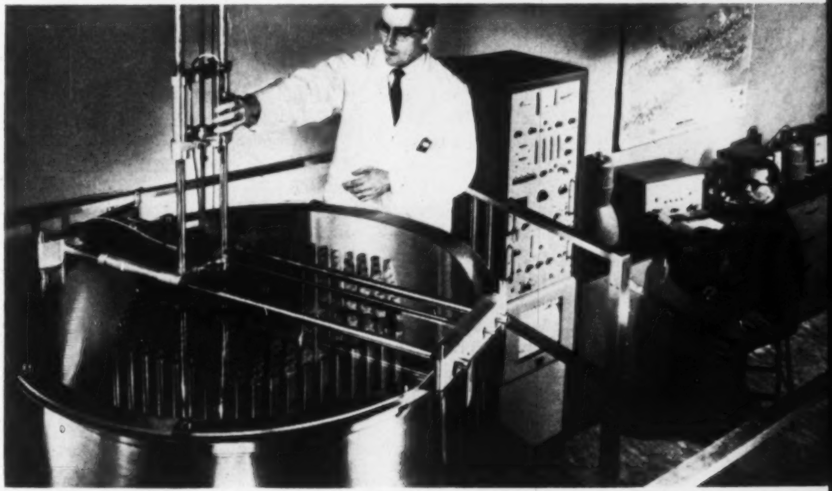
For more information, turn to Reader Service card, circle No. 437

Materials for Portable Nuclear Reactors

Reactors designed for research and training purposes pose special problems in materials selection. Both cost and weight must be minimized. Here is a look at current practice in fuels, controls, moderators, reflectors and shielding.

by Edward J. Mullarkey,
Technical Director,
Lead Industries Assn.



NC 9000 reactor *core consists of 275 aluminum tubes 1.25 in. in dia by 58 in. long arranged in hexagonal pattern and supported by two grid plates (not shown). The tubes are designed to hold 1 in. dia by 8 in. long natural uranium slugs whose total weight is 5500 lb. Uranium is made available to schools under AEC assistance program.*

■ Portable research and training reactors are widely used for instruction and orientation with nuclear physics and to explain the principles of reactor design and operation. They are also especially useful for radiation detection and health physics investigations, and in moderate-level tracer research.

Such reactors differ greatly in design from larger reactors. They are moderately priced and low powered. Also, shipment, installation, operation and maintenance are relatively simple, safe and inexpensive.

Like other reactors, portable reactors involve many compromises in materials selection. Unfortunately, nuclear materials do not always have good structural properties, and are often heavy, massive and expensive.

1. Fuel materials

Fuels can be liquid or solid

The fuel materials used in portable reactors can be liquid or solid and are usually enriched with fissionable U-235 so as to reduce size.

Homogeneous reactors use liquid or solution-type fuels, or fuel uniformly divided and dispersed in a solid moderator. Advanced reactors such as L-77 (Atomics International) and AGN 201 and AGN 211 (both Aerojet-General Nucleonics) are homogeneous reactors and provide the only practical experience with homogeneous systems to date.

Heterogeneous reactors use seperate fuel and moderator elements and are typified by the TRR (Nuclear Development Corp. of America) and NC 9000 (Nuclear Chicago) reactors. Heterogeneous portable reactors commonly use a so-called "canned" fuel element which, at the present state of the art, is giving ground to more efficient designs.

Design for minimum critical mass

The reaction rate and flux desired in a reactor fixes four factors: 1) the number of fuel atoms required per unit volume, 2) the ratio of fuel atoms to the atoms in the structure, 3) choice of coolant and moderator, and 4) operating temperature. Also, nuclear physics dictates the spatial distribution of fuel atoms within the core and, in the case of heterogeneous reactors, provides a first approximation of the shape and arrangement of fuel elements.

In designing a fuel system it is desirable to approach the minimum critical mass with a nonuniform fuel distribution arrangement. This approach, combined with judicious moderator and reflector selection, reduces fuel loading. And, from a safety standpoint, it insures that any rearrangement of the fuel will decrease reactivity.

Consider the effects of fuel growth

Solid fuels have a tendency to grow in preferential directions when irradiated. (Since low powered reactors produce low heat levels we can neglect the effects of heat transfer.) This growth is caused by elemental changes in the fuel as well as changes in chemical and structural properties. As burn-up proceeds, each fissioning atom is replaced by two fission product atoms (some existing as gases) which generally have a greater volume than the parent material.

The above effects tend to cause expansions and stresses in the fuel element and have to be accommodated lest they cause distortion. Distortion can affect coolant flow or the distribution of the moderator within the core matrix. And the resulting hot spots and disrupted flux patterns can result in shutdowns and costly repairs. Under such circumstances it is prudent to approach core design with the utmost feeling for safety.

Special liquid fuel problems

In principle, homogeneous reactors are based on the operational characteristics of the KEWB (Kinetic Experiment on Water Boilers) design. Unlike solid fuels, liquid fuels can be changed or removed easily and are free of the effects of anisotropy. Naturally, the materials retaining the fuels must resist corrosion and radiolytic decomposition. Because of its proper combination of structural, nuclear and corrosion properties, stainless steel is generally used in contact with aqueous uranyl sulfate fuel suspensions. Such suspensions should be completely free of harmful chlorides.

The problem of radiolysis with the water moderator in homogeneous reactors is only slight, since the free radicals that form tend to recombine and establish equilibrium. The L-77 reactor, for example, contains a recombiner unit containing platinized alu-

Nuclear Fundamentals of Portable Reactors

Portable reactors are thermal type

Nuclear reactors are classified by their predominant neutron energy spectrum and fall into three categories: thermal, intermediate and fast. Portable research and training reactors are thermal-type reactors and incorporate a moderator and reflector. The moderator slows neutrons released in the fission reaction to thermal energies where the probability for fission is great. As its name implies, a reflector returns to the core neutrons that would otherwise leak out of the system. The reflector permits a reduction in fuel requirements, thus reducing the cost of both fuel and construction materials.

Subcritical vs critical

Depending on their sustaining features, portable reactors are either subcritical or critical.

An important factor in this relation is the effective multiplication factor, *k*—the ratio of the average number of neutrons produced by fission in each generation to the corresponding number of neutrons absorbed in the fuel, moderator, etc., or leaking out.

If $k = 1$, the chain reaction is stationary and self-sustaining, or critical. If $k < 1$ the chain is not self-sustaining and is subcritical (without an extraneous neutron source the chain reaction cannot be maintained). If $k > 1$, the chain is divergent and the system is supercritical.

The k values for portable research and training reactors are equal to or less than 1. Flux is confined to 10^7 to 10^{10} n per sq cm-sec to avoid danger of overexposure and needless expense.

Effective multiplication is made up of two factors: the infinite multiplication factor $k\infty$ and the nonleakage probability. The $k\infty$ factor is the ratio of average number of neutrons produced in each generation to the average number of corresponding neutrons absorbed. Nonleakage probability, on the other hand, is a measure of the probability that neutrons will not leak out but will remain until absorbed to cause fission.

Some neutron leakage is desirable for research and training purposes. Extent of leakage depends on two factors: The first is the dimensions of the reactor. The second is the distance a neutron travels from its birth as a fission neutron to its ultimate absorption in an experiment. This distance is related to a quantity called the migration length.

Thermal utilization should be high

For every neutron absorbed by a fuel atom, 2.08 neutrons are produced. Of these, one must be captured by another fuel atom to sustain the reaction. Thus, at the most only 1.08 neutrons are available for experimentation. Also, some will be captured in the moderator and structural materials in the fuel region. The ratio of the number of captures in fuel to the number of captures in the fuel-plus-moderator-and-structure is the thermal utilization, *f*.

Since one of the 2.08 neutrons is captured in a fuel atom, $1/f$ represents the total number captured in the fuel region and $2.08—1/f$ the number that leak out of the fuel region. Thus, if f is 1 there will be 1.08 neutrons per U^{235} capture available for experimentation. This is equivalent to a maximum value of 3.3×10^{16} neutrons per sec absorbed in experiments for each megawatt of thermal power. This maximum figure is a constant independent of reactor design. Thus, to make a research and training reactor efficient the thermal utilization in the fuel region should be high and experimental facilities should be properly placed to receive neutrons leaking out.

mina catalyst pellets which recombine circulating hydrogen and oxygen gases to form water. The equilibrium of the water depends on impurities and the fuel solute which can create an excess of either peroxide or hydrogen. An excess of hydrogen tends to suppress decomposition almost completely. Conversely, an excess of peroxide tends to increase decomposition.

The L-77 reactor also contains an overflow chamber to offset possible fuel solution expansion caused by bubble formation. If expansion is great enough it will force some of the fuel solution into the overflow chamber, thus making the reactor subcritical (k becomes less than 1) and producing an automatic shutdown.

Hot gases can be beneficial

The gases generated in a reactor can be beneficial. For example, in a liquid fuel reactor such as the L-77, "hot" gas can be transported to remote experimental apparatus, giving the unit great versatility. About 10 curies (15 to 20% of the total) of volatile fission product activity is present in the L-77 under equilibrium conditions.

Unlike gases in the L-77 design, however, the gases generated in the AGN 211 reactor are not beneficial and cannot be used for other gainful purposes. In the AGN 211 core there are about 45 curies of radioactive gases present at steady-state operation. About one-third of the gas is harmful iodine-131. (Maximum permissible concentration for iodine-131 is 5×10^{-9} curies per ml or 5×10^{-9} curies per cu m of air.) However, this quantity of activity should cause no trouble. In order to be hazardous the iodine must first diffuse out of the uranium oxide particles, through the polyethylene element and its coating, and then escape from the water. This likelihood is extremely small.

Life of polyethylene core materials

Polyethylene is somewhat more radiation resistant than water and tends to trap any decomposition products or gases occurring in the matrix. Radiation damage manifests itself in reduced density and loss of hydrogen from the polyethylene after exposures of about one week at a flux of 10^{12} n per cm^2-sec. A flux time (nvt) extrapolation indicates that the core life of the material would be more than 10,000 hr based on an average continuous power of 100 w.

2. Control element materials

Reactors are controlled by changing the nuclear reactivity of the core. Change in positive reactivity can be made by moving the fuel, or by changing the moderator density or core leakage.

In the case of a reactor like TRR, simply changing the deuterium oxide level of the heavy water moderator permits fine "tuning" of the excess reactivity available. Fuel consumption can then be compensated for by adding small amounts of deuterium oxide, and the excess reactivity present need never exceed the desired low value of 0.75% k.

The AGN 211 reactor is even more flexible. Aside from certain disadvantages inherent in swimming pool-type reactors, this reactor has unrivaled accessibility and adaptability in its class. It is purportedly the only reactor in which the core materials and critical geometry can be varied in three dimensions without fabricating new fuel elements for each variation.

Changes in negative reactivity are made by changing the concentration of neutron absorbers or poisons in the core region. Such changes are typically accomplished in the AGN 211 reactor by two Boral safety rods: an aluminum-clad cadmium rod for coarse control and a stainless steel rod for fine control.

In a subcritical heterogeneous reactor using natural uranium and light water moderator (such as NC 9000), no control system is needed to prevent it from going critical accidentally. Natural uranium can go critical only when it is used in combination with heavy water.

3. Moderator materials

Neutrons released during fission have very large kinetic energies—as high as 2 mev (million electron volts). Moderation changes this kinetic energy to thermal energy by forcing the neutrons to collide with the nuclides of construction materials. The best moderator materials have low atomic weight, high scattering cross section, large energy loss per collision, and low absorption cross section for thermal neutrons.

Water, beryllium and graphite have good properties

In this discussion we can ignore aqueous homogeneous reactors since their moderator-fuel makeup is largely fixed. Although relatively expensive, heavy water, beryllium and graphite are eminently suited as moderator materials and provide lower fuel loadings than other materials such as light water. However, extra fuel loading in a light water reactor is advantageous since it enables the U-235 fuel to compete more favorably with water for neutrons in the fuel region. Thus, thermal utilization may be almost the same whether heavy water or light water is used.

However, apart from the above, the designer must transport, with minimum losses, the maximum number of excess neutron to where they can be experimentally used. Low absorption materials provide an efficient "piping system." Deuterium dioxide in particular delivers more neutrons per gram of uranium consumed than any other —its efficiency of delivery is almost 100%.

Organic materials are inexpensive

Less expensive moderator materials are also available with properties approaching those of heavy water, beryllium and graphite. In addition to light water, organic materials such as the polyphenyls, paraffin and polyethylene can be used. These organics are particularly interesting because of their:

1. High hydrogen-to-carbon atom ratio.
2. Compatibility with fuel, can and other structural materials, resulting in low corrosion rates.
3. Low induced radioactivity.
4. Elimination of hazardous chemical reactions.
5. Fair resistance to radiation damage (see table on p 113).

Organic moderator materials help to reduce cost since they can be used with inexpensive carbon and low alloy structural steels. They also permit weight reductions because of their compatibility with light, low-cross-section materials like aluminum.

Organics plus metals offer good combination

The fair resistance of the organics to radiation damage can be improved by mixing them with appropriate reflector, gamma shield or fuel materials. The composites perform dual roles, improving both the durability of the organic material and the effectiveness of the metal. Combination with lead or lead-lithium pellets, for example, reduces energy absorption by the organic material. This technique is used in the multi-region primary of the L-77 reactor.

The relatively poor heat transfer properties of the organics can also be offset by combining them with other materials. For example, intimately mixing hydrogenous organics with lead or other metals increases thermal conductivity and specific heat, thus allowing higher operating temperatures, eliminating hot spots, etc.

The AGN 211 reactor uses fuel elements made of 20% enriched uranium dioxide particles embedded in a radiation-stabilized polyethylene. This system has an inherent safety advantage due to the negligible time delay in the transfer of heat from the fuel particles to the polyethylene moderator. If something should go wrong the prompt heating of the moderator would increase the thermal energy of the neutrons and tend to reduce fission-to-capture probability. Furthermore, the prompt heat expansion in the fuel-moderator elements causes a decrease in density and increases leakage from the core, resulting in immediate shutdown.

4. Reflector materials

The purpose of a reflector is to return to the core leakage neutrons that are not intended for experimental use. The size of the core (fuel and moderator), its critical mass, and its cost are substantially affected by the presence of a reflector.

Important selection factors

Like the best moderators, reflector materials are characterized by a high scattering cross section and low neutron absorption. They should be chosen so as to:

1. Minimize costs.
2. Provide a large negative temperature and void coefficient (these quantities tend to increase with a decrease in reflector thickness).
3. Eliminate or reduce core-reflector interface flux peaking and smooth flux distribution in the core.
4. Properly control the flow of neutrons into experiments.

Lead reduces weight, cost

One of the most useful reflector materials for portable research and training reactors is lead. Important savings in weight and costs are obtained when it is used in the dual role of reflector and gamma shield. The homogeneous L-47 reactor (now replaced by the more refined L-77) was the first to use lead in this way.

Lead acts as an essentially infinite reflector in the L-47 design. This means that experimental apparatus used at or near the reflector surface will not perturb the neutron balance in the core. Furthermore, no hazard is presented in the vicinity of the reflector when the apparatus is moved during operation.

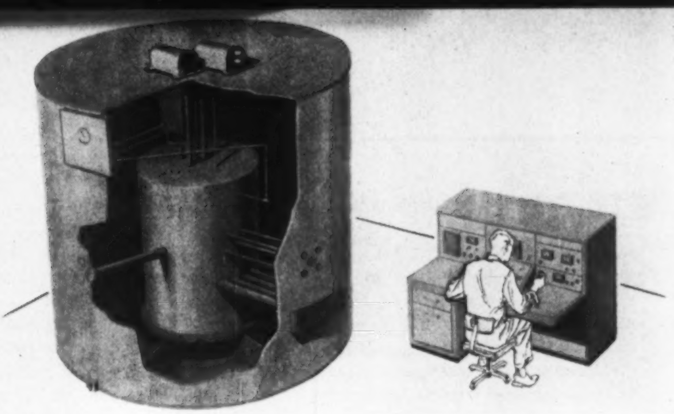
Also, since lead acts as an effective shield against in-core residual gammas, personnel have access to the interior when the secondary shield water tank is drained. In addition, since the lead is cast and bonded around the core vessel it helps improve the resistance of the core vessel to any sudden pressure surges that may occur.

The L-77 carried the use of multipurpose materials even further. Here an intimate mixture of lead shot and diphenyl is used inside the primary structure to provide neutron shielding or moderation in combination with gamma shielding or reflection.

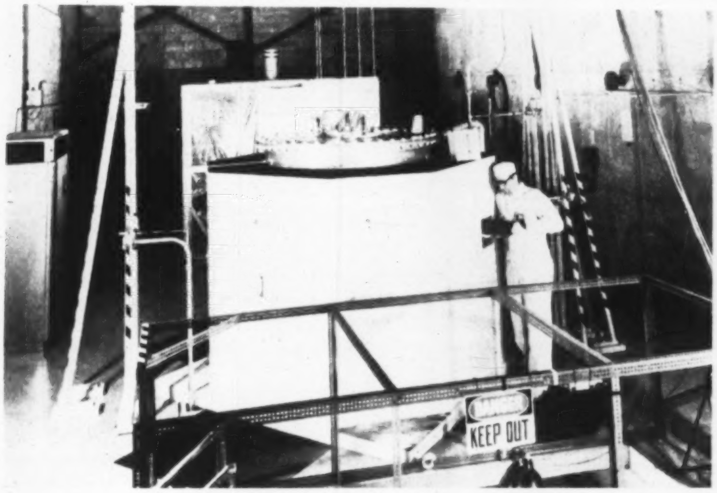
Composition hardboard also low in cost

Another popular reflector material is composition hardboard. Hardboard has good nuclear properties and maintains high neutron flux density within the core and experimental region. It is relatively free of impurities that absorb neutrons and has a large scattering cross section. Furthermore, it is inexpensive, readily available, and offers good resistance to moisture and heat.

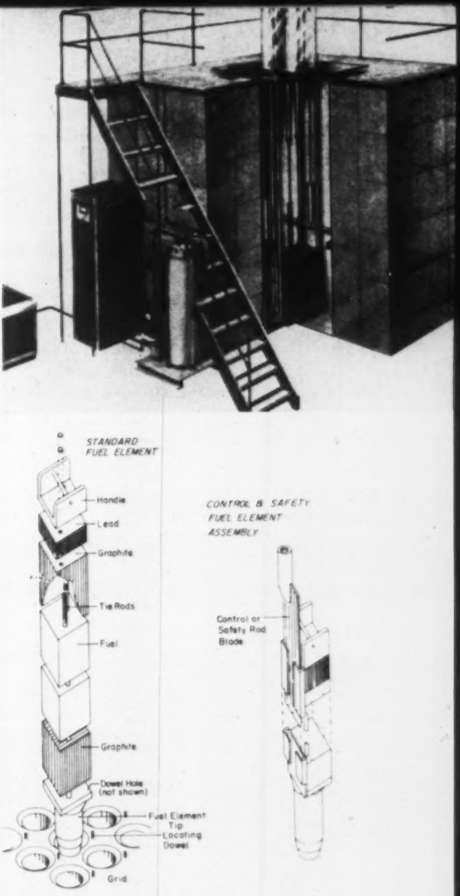
In designing the TRR reactor several reflector materials were considered, such as graphite, heavy and light water, beryllium and wood planking. Because of its low cost and other desirable properties hardboard was chosen



L-77 reactor *uses fuel of uranyl sulfate enriched to 20% or more in U-235. Moderator is light water; reflector is lead pellets in diphenyl material.*



TRR reactor *with shielding removed. Neutron reflector used on sides and bottom consists of 1 ft of graphite sheathed with 3 in. of masonite which in turn is covered with ½-in. layer of borated (8 to 10%) polyethylene shielding. Additional shield (not shown) consists of 6-ft layer of ordinary concrete blocks. Enriched uranium fuel is centrally located in aluminum reactor tank and is cooled by natural convection of heavy water.*



AGN 211 *reactor and fuel element assembly. Moderator is made of polyethylene, reflector of 3 to 5-in. thick graphite, and shielding of concrete. The center 10 in. of each fuel element is composed of a homogeneous mixture of uranium dioxide in polyethylene. A 5-in. graphite reflector is used at each end of fuel element and a 2-in. lead shadow shield is used at outer ends of graphite.*

to supplement graphite and heavy water reflectors. Cost of the hardboard for this application was $1.10 (all prices per sq ft) as compared to $38 for graphite, $600 for heavy water and $3000 for beryllium. Wood planking was rejected because it was less homogeneous than hardboard and more susceptible to warping and shrinking. Light water was rejected since it required a container that would be difficult to erect and modify. The hardboard is used in a 4-in. thick laminate made up of 5 layers, weighs 3.1 lb per sq ft, and is structurally self-supporting.

5. Shielding materials

Shielding falls into two broad classifications: thermal and biological. Thermal shielding is used to dissipate excessive heat from high absorption of radiation energy. It is not needed with small portable reactors because of their low power levels. Biological shielding, however, is needed to reduce gamma and neutron radiation at the outside surface of the reactor to a tolerable level—generally agreed to be 7.5 millirems per hr.

Unfortunately, materials that effectively stop neutrons are poor gamma absorbers. Up to about 3 mev, neutrons are attenuated best by low-atomic-weight materials. Conversely, good gamma absorbers should have high atomic weight.

In addition to having proper nuclear properties, shielding materials must be inexpensive and readily available since they are used in large quantities. Typical good shielding materials are lead, polyethylene, iron, concrete and water. Numerous metals may be used for shielding but lead is preferred because it can be used rela-

Three Important Design Objectives

1. Minimize radiation damage

Although the flux level in portable research and training reactors is usually lower than in other reactors, radiation can still affect the structural integrity of materials and components.

Radiation resistance depends on many variables and cannot be predicted with absolute assurance (see "Radiation Damage in Metals," M/DE, Jan '60, p 89). Complete assemblies may aid constituent parts or materials. On the other hand, the proximity of certain materials may render useless otherwise resistant materials. Some materials may have a lower threshold value than others, but may be more resistant to higher dosages. For example, nylon shows radiation damage sooner than TFE fluorocarbon, but with increasing dosage nylon maintains fair integrity long after TFE fluorocarbon has failed. Similarly, devices such as semiconductor diodes and triodes continue to function with degraded performance at dosages far above the damage threshold. In short, extrapolated damage data should be checked by actual tests.

The tables at far right show the approximate levels at which damage occurs for various reactor materials and components exposed to irradiation. These levels are conservative, and in most cases the specimens also received an equal number of gamma photons. From the data and considering power levels it is apparent that organic materials and some electrical components are most likely to be affected by irradiation. Selection of the most resistant material should be consistent with nuclear and cost requirements. Most instrumentation prone to damage can be relegated to remote consoles and positions. However, this may be impossible with electrical machinery, drive mechanisms, etc.

Electrical failures can be caused by insulation or lubrication breakdown. Formex and polyvinyl formal insulations for magnet wire appear to be quite resistant at medium temperatures. Nylon, polystyrene, polybutyral, mineral-filled phenol formaldehyde, polyester and furane plastics are all good organic insulations capable of withstanding high radiation dosage, although their physical changes must be considered in specific applications. Acrylic, TFE and CFE fluorocarbons, vinylidene chloride copolymers, casein, vinyl, epoxy and all cellulosic materials become poor insulations when exposed to high dosage. Alnico permanent magnets are not appreciably affected. Increasing radiation resistance is exhibited by the inorganic, inorganic-filled and heat resistant insulation materials. The best known insulations under intense radiation are glass and quartz which deteriorate very slowly.

No physical damage is observed in temperature sensitive devices such as thermocouples and resistance thermometers below dosages at which the basic materials are affected. The damage in these components is primarily caused by temperature rise due to irradiation. Radiation heating is a characteristic problem in energetic-type reactors and requires the use of pressure shells and special heat dissipation shields. It is not normally encountered in low-power "package" reactors.

2. Minimize corrosion

Salts containing boron are frequently used in water shields to further attenuate neutrons and to reduce radiolysis. Tests show the following range of corrosion rates (in mils per year) of metals in several borated solutions: lead, 0.1 to 0.6; mild steel, 0 to 0.3; mild steel-lead combinations, 0.3 to 0.9. These rates are negligible. Stainless steel can be expected to have still lower rates. Aluminum, however, despite its good corrosion resistance, is susceptible to galvanic attack.

An example of how corrosion can occur in portable reactors is provided by the NC 9000 reactor. Corrosion was traced to galvanic action between core components and the tank material. It was found that galvanic action could be stopped by replacing tap water with purified water having higher electroylytic resistance.

Corrosion can also be prevented by using suitable inhibitors in solution. Tests conducted with a 1630 ppm lithium chromate solution show that its inhibiting action is effective for at least six months with carbon steel, copper and lead.

tively thin, thus providing cost and weight savings.

Designing primary and secondary shielding

The primary or first shielding immediately surrounds the core or core structure. It is made of solid materials, is invariably leakproof, and in such reactors as AGN 201 and L-77 is made integral with the package. Great attention is required in its design since it comprises much of the overall cost and weight.

By nature of their design, swimming pool reactors such as AGN 211 do not have a leakproof primary shielding. However, the induced core radiation level of this reactor is low enough for safe fuel handling while providing sufficient flux for many activation experiments.

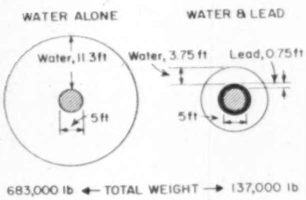
Secondary shielding is not considered part of the reactor package since it is usually erected on the site. Water and/or concrete blocks are frequently used as secondary shielding. Unlike primary shielding, secondary shielding is not used in equal thickness around the entire reactor. Secondary shielding requirements above or below the reactor can be minimized by taking into account the benefits of the foundation or floor below the reactor and uninhabited air space above the reactor.

In most designs access to the

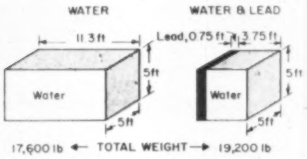
3. Minimize weight

Naturally the weight of portable reactors has to be kept to a minimum. However, compromises in materials selection are inevitable, and the usual practice is to use mixtures or layers of gamma and neutron absorbers.

Simple geometry tells us that considerable weight savings are obtainable with circular polyshields. The first drawing below shows the approximate weight difference in two shields designed to provide the same dose constraint. As indicated, the lead-water design has a considerable weight advantage over the all-water design. Similar comparisons for slab-type shields are shown in the second drawing.



Comparative weights *of spherical shields made of water alone and double layer of water and lead.* (Hemmid)



Comparative weights *of slab shields made of water and water plus lead.* (Hemmid)

SUMMARY OF DAMAGE THRESHOLDS FOR REACTOR MATERIALS AND COMPONENTS

Material or Component	Radiation Level, nvt[a]
Ductile and Fluid Metals (control poisons, shields, reflectors)	3×10^{22}
Many Simple Inorganic Compounds	3×10^{20}
Plastics (moderators, shields, reflectors)[b]	1×10^{15}–1×10^{19}
Bearings in Special Lubricants	6×10^{17}
Permanent Magnets	3×10^{17}
Capacitors and Small Motors[b]	1×10^{17}
Resistors, Small Transformers, Electron Tubes[b]	3×10^{16}
Dry rectifiers	1×10^{16}
Organic Fluids (oils, greases, shields, moderators)[b]	1×10^{16}
Silicon Diodes	1×10^{13}
Transistors	1×10^{12}

[a] In most cases samples also received an equal number of gamma photons.

[b] See also tables below.

RADIATION DAMAGE TO REACTOR AND SHIELD COMPONENTS[a]

Material ↓	Type of Damage	Estimated Threshold Damage (25%), rads
Water	Gas evolution, corrosion	Infinite
Paraffin and Olefin Hydrocarbons	Gas evolution, polymerization	1×10^8
Monopheynl Hydrocarbons	Same as above	3×10^8
Diphenyl and Polyphenyl Hydrocarbons	Same as above	1.4×10^9

[a] From V. P. Calkins, "Radiation Damage to Nonmetallic Materials," (unclassified AEC report).

[b] 1×10^8 rads corresponds approximately to combined radiation of 3×10^{17} thermal neutrons/sq cm, 3×10^{16} fast neutrons/sq cm (above 0.7 mev), and 1.5×10^{17} gammas/sq cm (average energy = 1 mev).

RADIATION DAMAGE TO CONTROLS AND INSTRUMENT COMPONENTS

Component ↓	Radiation-Susceptible Material	Estimated Threshold Damage (25%), rads
Capacitor	Paper or oil dielectric, phenolic or wax paper cover	4.5–7×10^6
Resistor	Plastic cover	4.5–7×10^6
Microswitch	Plastic case and actuator	4.5–7×10^6
Selsyn	Organic wire insulation, brush holder, slot liners, and punchings and casing insulation.	4.5–7×10^6

reactor is lateral or radial and it is in these directions that shielding requirements and dimensions are greatest. Thus, reactors are generally somewhat wider than they are high. However, overall diameter is usually kept under 8 ft to facilitate transport. When water or some other liquid is used for secondary shielding the tank can double as a structural support for the core and/or the primary shielding.

The AGN 211 and NC 9000 reactors differ from others in that experimental access to the core is from the top of the reactor. Shielding for the AGN 211 in the radial directions is provided by 40 in. of concrete in the form of overlapping blocks. Vertical shielding is provided by 6 in. of graphite, 2 in. of lead and 4½ feet of water.

Attenuating neutrons

Neutrons are absorbed in two stages. First, high energy neutrons passing through a shield are slowed by elastic or inelastic scattering; the capture cross section for neutrons at high energies is extremely small. The second stage of capture occurs only when the energy of neutrons drops to low values. Large cross sections of most elements will produce quick capture of low energy or slowed neutrons. Therefore, the usefulness of neutron shield materials depends largely on their ability to attenuate high energy neutrons.

Elastic and inelastic scattering are produced by collisions between high energy neutrons and the shield nuclei. In inelastic scattering the recoil nucleus is left in an excited state and it therefore absorbs a larger fraction of energy than it does with elastic scattering. In general, inelastic scattering is more important with heavier nuclei which can be more easily raised to excited states. Elastic scattering is more important with light nuclei which can absorb a large amount of energy via recoil.

Neutron shielding must also be designed to protect against secondary gamma radiation produced by inelastic scattering and capture. This can be done by incorporating absorbers such as boron which reduce the energy of capture gammas and remove low energy neutrons as they are produced. Boron can be used in the form of soluble or insoluble salts, depending on the medium, or in the form of Boral, a mixture of aluminum and boron carbide. The TRR reactor uses a borated plastic; the L-77 reactor uses borated paraffin.

Attenuating gamma radiation

The effectiveness of a material in shielding against gamma radiation depends strongly on its specific gravity or atomic number, i.e., electron density. It is useful to remember that a gamma intensity of 2 mev is reduced by a factor of ten by 19 in. of water, 10 in. of concrete, 2.6 in. of iron and 1.7 in. of lead.

Gamma shields in themselves are also a source of neutron-produced gamma radiation or secondary radiation resulting from capture. This adds to the secondary emission of hydrogenous shields and to the attendant weight of shielding required. According to *Jansen et al*, a lead-lithium alloy shows good potential protection. Because of its thermal neutron absorption properties, lithium is effective in suppressing gamma ray production resulting from neutron interaction with lead. The alpha radiation produced has an extremely short range—several microns in lead—and is comparatively harmless. Although the alloy tends to corrode in air and water, corrosion can be prevented by incorporating it in hydrocarbon materials. Lead is virtually inert to nonpolar hydrocarbons and only slightly attacked by most polar materials.

Use of a lead-boron alloy for gamma shielding has not proved feasible because boron is only slightly soluble in lead. Similarly, production of the alloy by powder metallurgy has not worked out because of segregation problems. However, a cementation technique developed by Battelle Memorial Institute appears promising (see *Williams et al*).

Composite shielding combines advantages of single materials

Organic-lead mixtures are advantageous where it is desirable to have a hydrogenous material for neutron attenuation together with a heavy material with a high neutron inelastic cross section but low gamma ray production efficiency as the gamma attenuator. Since carbon is a good source of hard gammas when bombarded by high energy neutrons, it is desirable to distribute lead throughout carbon shields. In addition to satisfying nuclear requirements, mixtures of lead pellets and organic materials provide good design flexibility and inherent safety. Also, homogeneous mixtures are easily cast into shapes and easier to work with than laminated layers.

Spherical lead pellets have been used to advantage in the unique primary shield of the L-77 reactor. This shield consists of three concentric regions. The innermost region is composed of a mixture of lead pellets and diphenyl which surrounds a stainless steel sphere containing uranyl sulfate. It acts primarily to reduce neutron leakage, moderate escaping neutrons, and attenuate gamma radiation. The central shield region is composed of borated paraffin which further moderates radiation and captures a significant portion of thermalized neutrons. The third region, made of a mixture of lead pellets and paraffin, acts as a neutron-gamma shield.

Mixtures of lead and paraffin should be made as light as possible. Since neutrons create hard gammas in the carbon of the paraffin, there is no need to have more lead than is necessary to reduce the core gamma strength to approximately the same level as the neutron-induced secondary gamma strength. (Boron additions can serve to reduce the secondary gamma level. Lithium on the other hand could reduce the contribution of lead and the hydrocarbons.) This may suggest use of lead powder suspensions; however, these could tend to separate by gravity over prolonged periods at moderate temperatures. This would not be the case with pellet shields.

According to *Race*, cylindrical pellets would be less expensive than most spherical pellets. Also, the effective density of composite shielding can be varied without affecting the packing factor by using a cylinder of one material (e.g., carbon steel) with a liquid core or core of another metal (e.g., lead). This arrangement permits uniform materials distribution—more so than a random mixture of solid pellets of different materials. Also, by using cylindrical pellets to realize a specific packing factor, it is possible to obtain a range of gamma and neutron stopping ratios by changing pellet core size and the filling material. The average packing factor for a random arrangement of single-size cylinders (with length equal to diameter) is 0.366—slightly less than that of random-packed, single-size spheres which have a packing factor of 0.4.

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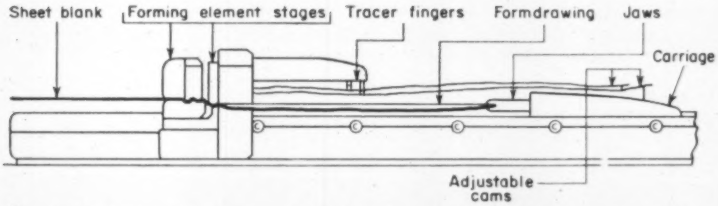
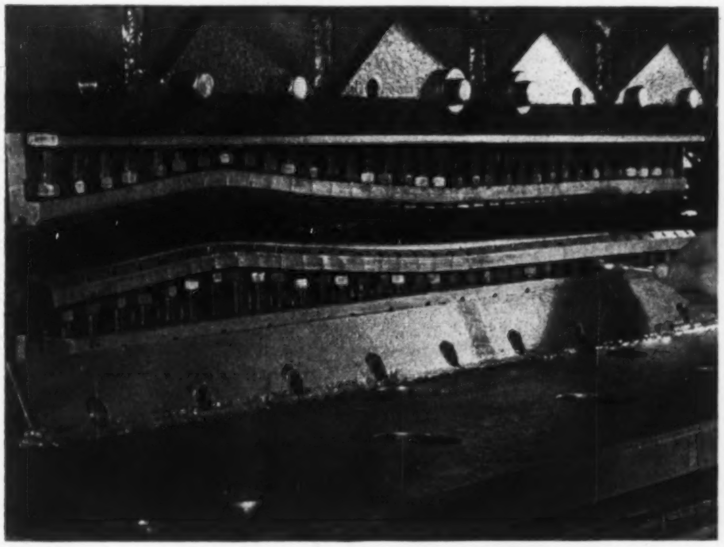


1 ***Androform machine*** *as shown by schematic drawing through centerline.*



2 **Closeup view** *of adjustable forming element.*

Bending Plus Stretching Cuts Cost of Contoured Sheet Parts by ...

- *Eliminating dies and thus cutting lead time*
- *Forming difficult metals*
- *Eliminating intermediate treatments*
- *Reducing scrap*

by Donald Peckner, *Associate Editor,*
Materials in Design Engineering

■ A sheet metal forming process developed by Anderson Aircraft Corp. eliminates the need for the large number of dies required in conventional stretch forming operations. Although developed primarily for the aircraft industry, the process should find applications outside this field. Other products that might be manufactured by the Androform process include: automotive body panels, truck structural panels, boat hulls and architectural panels. A typical current application is forming segments for a 60-ft dia radar reflector.

How the process works

The Androform process is basically a differential stretch forming technique. Sheets are contoured by varying the shape of a standard set of forming elements. The machine (see Fig 1) is composed of three basic forming element stages. Stage 1 plastically bends the blank in the longitudinal direction (radius of curvature lengthwise to the sheet); stage 2 plastically stretches the blank in a transverse direction. Stage 3, essentially, acts as a wiper on stage 2 to prevent or control compression buckling of the sheet. Fig 2 is a close-up view of the stage 3 element.

Manipulation of these three forming elements is automatically controlled hydraulically by the use of tracer fingers (or followers) that are actuated by several adjustable, segmented templates. As the gripper head pulls the sheet between the forming elements the followers trace over templates and regulate: a) gap (and, therefore, tensile force applied by stage 1); b) gap and bending moment applied by stages 2 and 3; c) relative vertical positions of stages 2 and 3 with respect to stage 1; d) relative horizontal spacing between stages 2 and 3 and stage 1.

Controlling the relative positions of the forming elements in stage 1 with respect to each other results in an initial tensile force on the sheet at or near the yield strength of the material. Additional loads are required in stages 1, 2 and 3 to produce simultaneous bending in both the longitudinal and transverse directions. Applying bending stresses at right angles to each other and superimposing a tensile stress establishes a multiaxial stress distribution which allows flow to occur at a maximum stress lower than that required to produce flow by tension alone (as in stretch forming).

By controlling the relative spacing between forming elements, the neutral axis during bending (in either plane) can be adjusted to be in the center of the sheet (pure bending), outside the sheet on the concave side (pure stretching) or any location between (for combined bending and stretching).

What are the advantages?

Androforming has several important advantages over standard stretch forming procedures. Since no forming dies have to be made, lead time is almost completely eliminated. Scrap losses are reduced as much as 95%. Other advantages are: alloys with poor formability characteristics are readily formed at ambient temperatures; formed parts have smoother surfaces; and many intermediate steps such as annealing, heat treating and prior preparation are eliminated.

Materials that can be formed

To date, the following metals have been formed:

Aluminum alloys: 2024T3, 2024-T81, 7075T6, 7178T6.

Stainless steels: 301 (full hard); 302 (full hard); 17-7 PH: AM350 (½ hard); AMS5532.

Titanium alloys: AMS 4900; AMS 4901; AMS 4908; RS110AT: 6A1-4V.

Magnesium alloy: AZ31A.

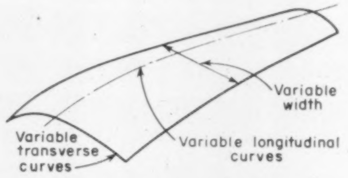
Shapes, sizes, reproducibility

Fig 3 is a sketch showing how the surface of an Androformed panel may be varied. Thickness of the formed parts is uniform and the formed panels are identical. Fig 4 shows stacked skins which illustrate the uniformity of the process. Shapes can be widely varied as follows: simple contour, compound contour, convex-concave contour or combinations of these three forms. The centerline of the contour can be made parallel to the panel sides, at an angle to the panel sides, or on an arc or curve.

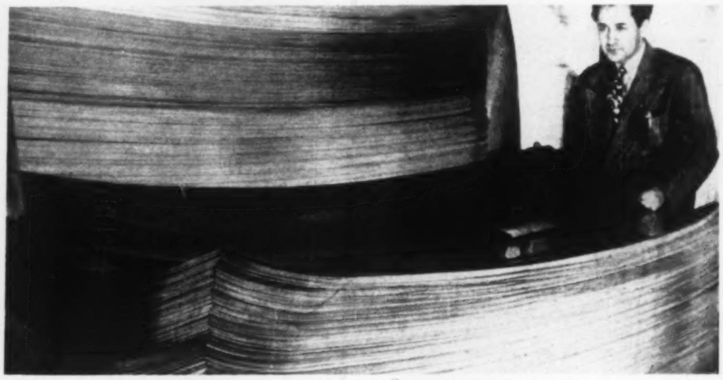
Maximum contour that can be formed is dependent on variables such as difference in length and gage of the starting sheet and the yield point of the material.

Androforming allows the designer to consider the possibility of forming parts in one continuous sheet rather than as a series of welded or riveted components. Machine capacities range in metal thickness from 1/8 to 9/16 in., widths up to 120 in. and lengths as long as 48 ft.

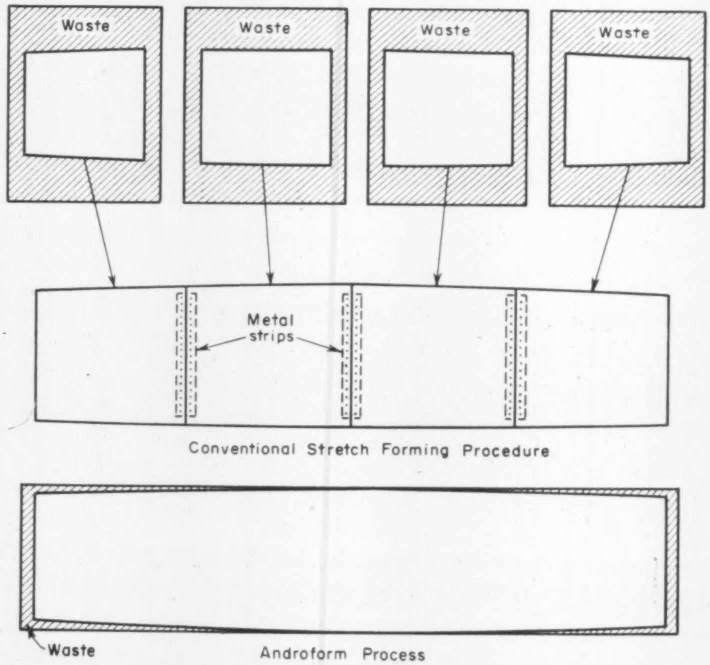
Fig 5 shows the difference between standard stretch forming procedure on a bomb bay door and the Androform process. As a result of Androforming the door, up to 50 percent of the metal normally required is saved, the door is subjected to a minimum of cold working, residual stresses are distributed uniformly throughout the part, weight of the part is reduced by elimination of rivets and reinforcing strips at the joints, and tool costs are practically eliminated.



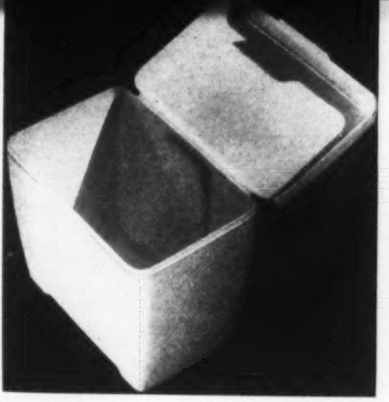
3 ***Variable compound curvatures*** *with constant thickness can be obtained with Androform process.*



4 **Stacked panels** *made by process show that parts are uniform..*



5 **Bomb bay door** *made in one Androform operation eliminates four panels and need for joining.*



Record case—*Simple integral hinge provides low cost efficiency in the Platter Porter record case produced by Columbus Plastics Products, Inc.*

Glasses case—*Integral hinge makes economical, attractive case for safety glasses. According to producer, Parmelee Plastics Co., cases were opened and closed 1000 times (equivalent to a year's normal service) with no appreciable weakening of hinge area.*

These original designs show potential of . . .

The Polypropylene Hinge: Long Life at Low Cost

How it works . . . how to design one . . . and some outstanding examples of successful use

by Malcolm W. Riley,
Associate Editor, Materials in Design Engineering

■ Substantial cost and performance benefits are being realized through the use of a unique "hinge characteristic" of polypropylene. Flexible plastics such as vinyls and low density polyethylenes have been used previously for flexible hinge-type components. But in polypropylene you have a rigid yet resilient material which, in thin sections, provides virtually unlimited flex life. Consequently, relatively rigid components such as containers can be molded with integral hinges.

All the applications discussed in this article use Pro-Fax, the polypropylene produced by Hercules Powder Co.

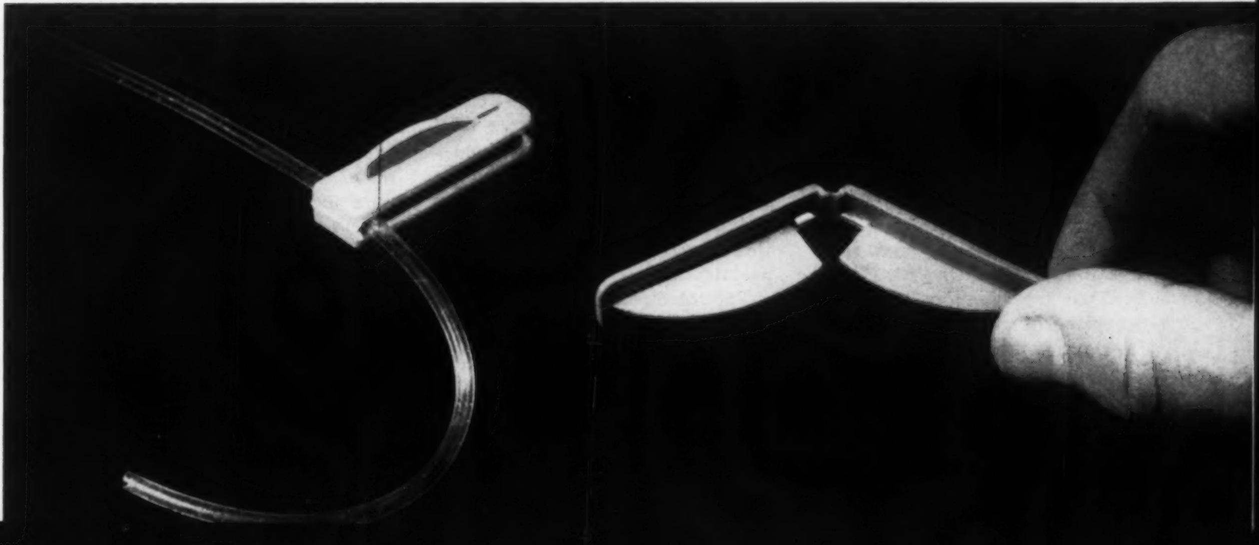
Why and how the hinge works

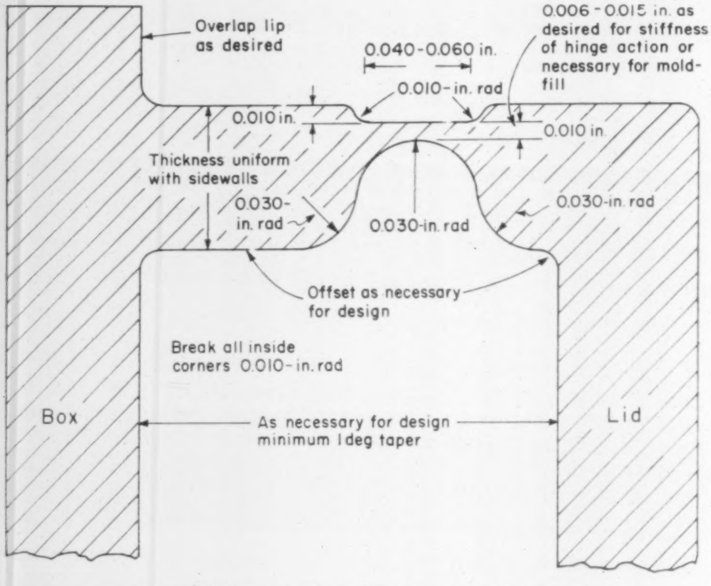
Why the material behaves the way it does is not fully understood. It undoubtedly involves such characteristics of polypropylene as 1) its crystalline nature which permits substantial increases in strength through orientation or stretching, 2) its high elongation beyond the yield point, 3) its complete resistance to stress cracking, and 4) the fact that it forms a tough skin during molding or extruding.

Here is the explanation given by R. D. Hanna of Hercules Powder Co.: As molded, a polypropylene hinge web has unit tensile strength and stiffness equivalent to that of any other section of the molding. It therefore has some resistance to flexing. However, on the first flex of this relatively confined area, fiber stress in the

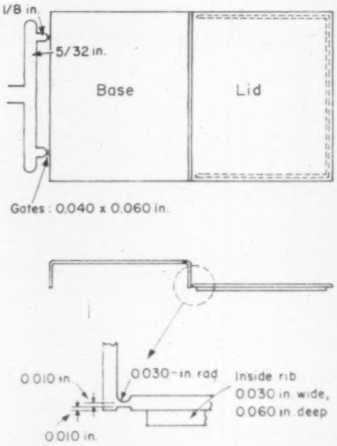
Photos this page courtesy Hercules Powder Co.

Tubing clamp—*Low cost, disposable clamp for tubing required excellent environmental stress cracking resistance, and is intended for use at most about a dozen times. Developed by Pacific Plastic Products, this polypropylene clamp has been cycled 250,000 times without hinge failure.*




Overlap lip
as desired
0.040-0.060 in.
0.006-0.015 in. as desired for stiffness of hinge action or necessary for mold-fill
0.010-in. rad
0.010 in.
0.010 in.
Thickness uniform with sidewalls
0.030-in. rad
0.030-in. rad
0.030-in. rad
Offset as necessary for design
Break all inside corners 0.010-in. rad
Box
As necessary for design minimum 1 deg taper
Lid

1—Design recommendations for a standard polypropylene hinge. (Hercules Powder Co.)


1/8 in.
5/32 in.
Base
Lid
Gates: 0.040 x 0.060 in.
0.010 in.
0.030-in. rad
Inside rib 0.030 in. wide, 0.060 in. deep
0.010 in.

2—Layout for mold design indicating optimum arrangement for flow of material. (Hercules Powder Co.)

outer surface causes elongation exceeding the yield point, thus orienting the crystallite structure and causing necking down in that area. Such orientation increases tensile strength. Further flexing will increase orientation and the hinge will actually become stronger with use. (For further information on effects of orientation see "Oriented Thermoplastic Sheet and Film," M/DE, Dec '59, p 94.)

Other thermoplastics, such as high density polyethylene, have several of polypropylene's characteristics. But none appears to provide the balance of properties required to give hinge performance comparable to that of polypropylene. For example, one laboratory reports flexing a polypropylene hinge 300,000 times over a 180-deg angle at both 75 and –20 F with no indication of failure. Others report discontinuing tests after 1 million flexes with no evidence of failure.

Hinge design: simplicity itself

Design is simple. A sketch of Hercules Powder's standard hinge design is shown in Fig 1. Essentially the polypropylene hinge is a molded or cold formed web similar to a flash gate. Land length (or hinge width) should be 0.040-0.060 in. or greater, depending on the function of the hinge. Web thickness should be 0.006-0.015 in., depending on either the stiffness desired in the hinge action, or the requirements for filling the mold. Ideally, flow of material should be from the base or heavier section through the hinge area and into the lid or lighter section, as shown in Fig 2. In any case, for best performance flow should be through the hinge and perpendicular to the hinge line.

All corners in the area of the hinge should be radiused to improve both flow of the material and physical properties of the part. Typical radii are shown in Fig 1.

To increase rigidity and improve the fit of hinged mating parts, a lip or other interlocking feature should be incorporated in the design.

In cases where molding in the hinge may be costly or difficult, successful hinges can be cold formed. The thin hinge web can be postformed by such a device as an arbor press which can force the material to cold flow under moderate pressure.

Three case histories

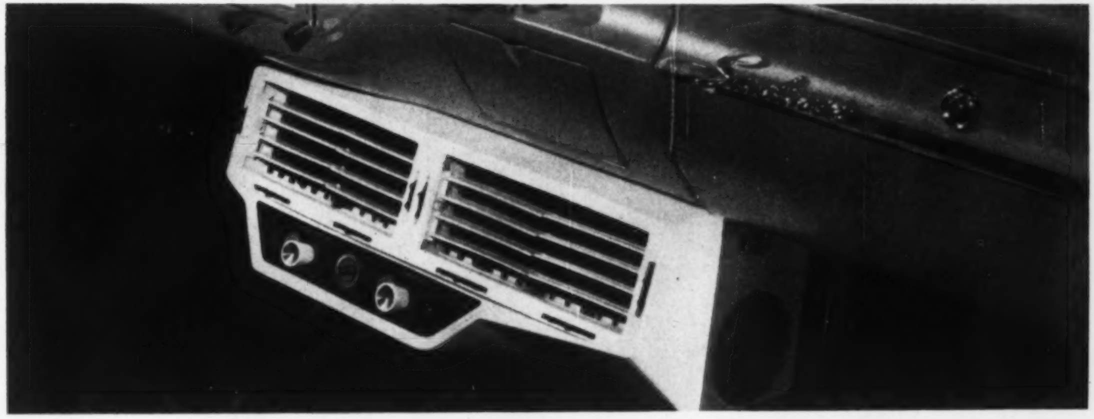
Auto air conditioner registers—lower cost, lighter weight, more efficiency

Air deflection registers for car air conditioners have been redesigned by Eaton Mfg. Co.'s Heater Div., to make use of the polypropylene hinge. According to R. D. Emery, project engineer, the redesign resulted in 66% reduction in cost, 68% reduction in assembly time, 92.5% reduction in weight of the unit, and elimination of rattles and squeaks as well as lubrication.

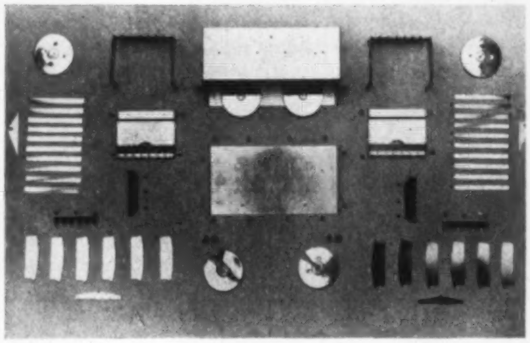
The accompanying pictures show exploded views of the design in metal and the design in polypropylene, as well as the registers installed in a car. In the exploded view of the new design, the two large parts in the center show the molded deflectors with integral molded-in hinges. Each of the blades is connected to a rigid base bar by a thin membrane which serves as the hinge. All the

AUTO AIR CONDITIONER REGISTERS

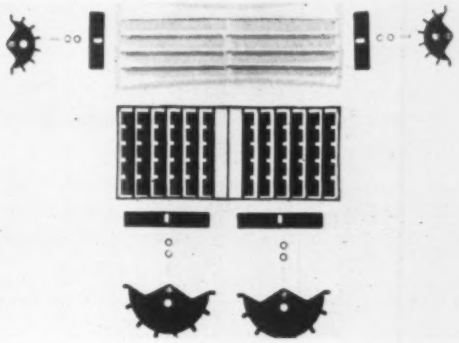
Photos courtesy Eaton Mfg. Co.



Complete assembly *with polypropylene hinged deflectors installed in car.*



Before . . . *Exploded view of parts required for old metal register assembly*



After . . . *Exploded view of parts required for new polypropylene register assembly. Deflectors on moldings in center are integrally hinged to base bars.*

base bars are molded to a common frame.

According to Emery, several sets of louvers were life-tested by deflecting them through an included angle of 120 deg at a rate of 360 deflections per hour. All the blades withstood 300,000 deflections at temperatures ranging from 0 to 200 F. No weakening of the hinge section was found.

Other benefits included excellent, glossy surface finish with a good "feel," good dimensional stability, and high resistance to grease, oil and ultraviolet light.

Original tooling costs were somewhat higher for the injection molding dies than for the blanking and coining dies required for metal fabrication.

Auto accelerator pedal—lower cost, improved operation

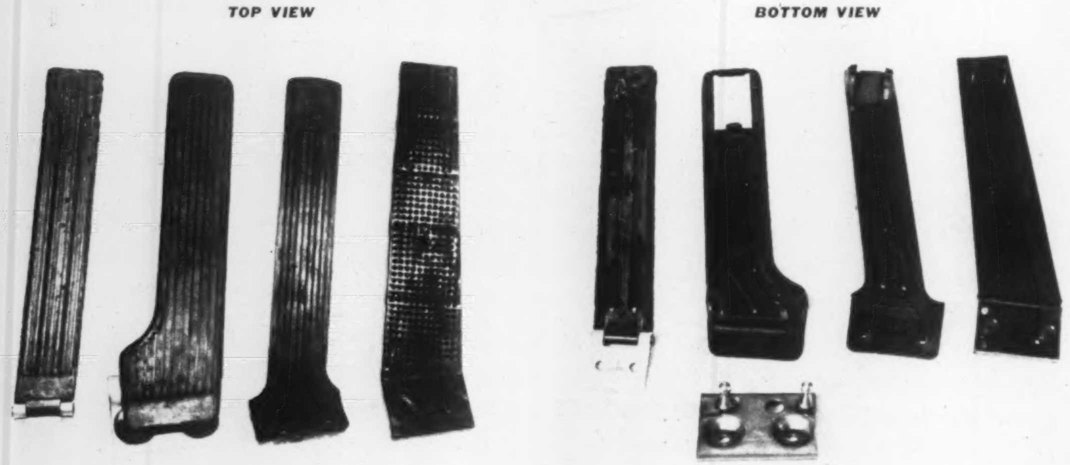
On the threshold of commercial use are polypropylene accelerator pedals with integrally molded hinges. A rough prototype of the pedals, developed by Millington Mfg. Corp., is shown at the right in the photos on the next page comparing the various types of pedal constructions in common use. Although data are unavailable as yet from specific auto manufacturers, all the major producers are reported to have such pedals under evaluation.

Although present pedal designs vary, as shown in the photos, most pedals combine metal and rubber: In some, metal is used in the hinge, as well as providing structural support; in others, metal provides only rigidity and the rubber serves as the hinge.

Compared with such constructions, polypropylene pedals are reported to provide a reduction of from 50 to 70% in initial cost, lighter weight, and further economies in accessory parts and assembly time. The molded pedals can be altered to permit installation with any conventionally used attachment system.

Polypropylene pedals are reported to have been tested by flexing ½ million times with no load, then ½ million times under loading experienced when the pedal is "floorboarded," at both subzero and elevated temperatures. No bad effects were noted.

ACCELERATOR PEDALS



Prototype polypropylene *accelerator pedal, developed by Millington Mfg. Co. is shown at right of both photos which compare it with conventional pedals. Other pedals are (left to right): Studebaker rubber-covered metal pedal with all-metal hinge; Chevrolet rubber-covered metal pedal, attached by spherical bosses on metal floorplate; Ford rubber-covered metal pedal with rubber hinge. Top view shows different attachment methods. Polypropylene pedal can be adapted to fit any of the conventional designs.*

Additional advantages over rubber surfaced pedals include better wear and abrasion resistance, and excellent resistance to road surfacing compositions and other chemicals and greases.

Many styling possibilities exist. Polypropylene can be colored to match interior trim, or symbols and nameplates in contrasting colors can be molded-in or subsequently applied.

Air conditioner retainer strip—simplified assembly, efficient operation

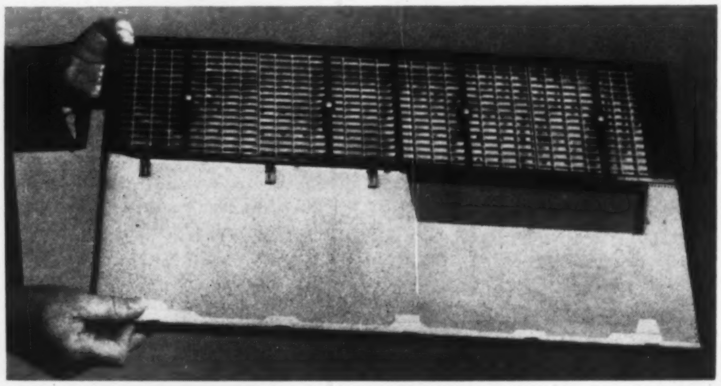
In the redesign of the 1960 Westinghouse room air conditioner, the hinging characteristic of polypropylene was put to use in the filter retainer strip shown in the accompanying photo. The strip has three integrally molded hinged clips that snap-lock in place when the filter is installed. The hinge membranes are 0.006-0.008 in. thick and 0.020 in. wide.

Since this was an overall redesign of the front of the air conditioner, no direct comparisons are possible. However, Westinghouse reports that the polypropylene strip replaces an adhesive bonded plastics assembly with S-shaped wire snaps which held the filter in place.

According to F. S. Metcalfe, of Westinghouse's Product Engineering Dept., polypropylene was selected for this strip primarily because of its hinging characteristics, as well as its rigidity which permitted the snap fit. Metcalfe also says polypropylene's molding qualities were found to be reliable and no problem was encountered in warpage and distortion.

Flex fatigue in the hinge was not considered a problem. In the normal life of the unit, the filter would probably not be changed more than 100 times. Westinghouse flexed the hinges about 2000 times with no indication of failure. At time of writing 100,000 such units are reported to have been sold with no reports of failures in this part.

AIR CONDITIONER RETAINER STRIP



Retainer strip *for Westinghouse Room Air Conditioner has three integrally molded hinged clips which hold air filter.*

HOW MUCH WILL IT COST?
HOW LONG WILL IT LAST?
WILL IT DO THE JOB?
IS IT SAFE TO USE?

Your Specifications

Can Make You or Break You

Here are some pitfalls you should avoid.

by Alfred K. Thornton, *Chemical and Materials Evaluation Dept., United States Testing Co., Inc.*

Keep your requirements in balance

Meaningful specifications represent a delicate balance between economy and satisfaction of all end-use requirements. And they call for the best minds in a company, seasoned judgment and sound evaluation.

Every successful product must satisfy three important requirements, all of which are limited by cost:

1. Is it safe to use?
2. Will it do the job?
3. Will it stand up during its required life?

We see all of these requirements in *balance* with products that are operating successfully and are being made at a profit. We see an *unbalance* when there are accidents, poor performance and breakdowns—in short poor reliability. Then, one or more of the requirements has been violated.

The most important objective in producing any product is to get the right balance of requirements. Too much emphasis on any one requirement is often as bad as too little. The designer who over-specifies to play it safe or because of a mistaken idea of quality can hurt his company's competitive position. Contrarily, the designer who under-specifies through false economy can damage his company's reputation. And last, the designer who does not use any specifications at all and relies on an informal system of quality control is leaving his company wide open for trouble.

In short, remember the parable of the one horse shay. It was *very safe* for many years and it *did its job* exceptionally well. As far as *durability* was concerned, it was designed so that no one part was better than any other. They all gave out at once! The maker had a good spec.

Overdesign: safe but costly

It is a natural and laudable tendency of many designers to specify maximum mechanical and physical properties in their products. However, this practice can lead to high costs.

Take the case of the designer who drew up a driveshaft for a new pump his company was introducing. Using his handbook as a guide, he selected a high strength steel and then specified a depth of case hardening well in excess of any possible demand. Though the designer met the requirements of utility and safety, the cost of his product was out of bounds. Fortunately, when the design reached the Product Planning Dept. realistic corrections were made.

Then there was the manufacturer of zinc-plated steel parts who ran into an epidemic of poor plating and rejects and arbitrarily ordered his shop to over-plate. Several years later when new management took over it discovered that reasonable quality control procedures could have eliminated the rejects and need for over-plating. And the resultant savings would have paid for the quality control measure many times over.

Many other examples could be cited—such as specifying fluorocarbon plastic seals when ordinary rubber would do, or using high quality admiralty brass when commercial brass fittings would do. In all of the above instances economy lost out at the expense of more than meeting other demands.

Underdesign: cheap but unsafe

Underdesign and product failure go hand in hand. Some of the most dramatic examples of underdesign are those where the product proved unsafe. Designing a safe product involves a thorough knowledge of service demands and some imaginative thinking about unlikely, but possible, demands.

For example, a manufacturer of toy hobbyhorses supported the child's seat and handle on a flexible steel strip one end of which was fastened to the steel frame. A number of cases of strip breakage and children spilling resulted in one parent's sending a unit to our laboratories for evaluation. After a relatively small number of cycles fatigue set in and the strip snapped. This is a case where the requirements of safety and durability overlapped.

Similarly, a manufacturer of baby furniture decided to introduce his products in a new geographical area. Luckily, a major department store decided to conduct an independent evaluation of his line. His products were good except for the bassinette. Every part of this was good too, except the bottom of thin fiberboard which broke when a replica of a baby was dropped from about 2 ft into the bassinette—an accident that could easily happen. Here the demands of safety in the improbable, but possible, area were not met.

Watch out for carry-over specs

Sometimes specs are carried over from previous designs or are pieced together from related products. Such practices can be costly.

For example, a mattress manufacturer had an overall spec for the various materials of his product. The spec for the springs was taken from a product with far more severe service requirements than his mattresses. With the heavy duty springs his mattresses cost more than they should have.

Changing requirements can cause trouble

In today's fast-changing markets new applications are constantly being found for materials. These new applications create new requirements and negate old requirements. An alert manufacturer should constantly check his material specifications if he wants to take competitive advantage of change.

An example of this problem is a plastics manufacturer who was supplying a plastic with excellent dielectric properties to extruders of insulation. As time went by, higher environmental demands made his material obsolete for insulation and he had to turn his business towards consumer products. Evaluation of his material showed that it could satisfy the specifications for shower curtains requiring high strength and tear resistance. It also showed that he could cut costs if he eliminated the specs on high dielectric properties which were obviously no longer required.

A contrasting situation occurred when a manufacturer of plastic upholstery fabric neglected to include in his specification requirements for resistance to light aging and hot and cold weathering. He had always made indoor furniture upholstery and these properties had never been necessary. But when he started making outdoor furniture he soon ran into severe trouble due to cracking, discoloration and plasticizer migration. As a result he had to take the product off the market and work out new specs to provide resistance to environmental conditions.

Prepare to use alternate materials

Unnecessary delay and hardship are often caused by an unwillingness to specify suitable alternate materials. For example, a process equipment fabricator agreed to make a 304 stainless steel pressure vessel for a large chemical manufacturer. Unfortunately, the supply of 304 stainless ran out and the fabricator substituted 316 stainless—at no extra cost to the customer. The vessel was rejected by the customer even though 316 stainless would do all and more than the 304 stainless would do.

Don't ignore specs altogether

Many manufacturers are still willing to take the risk of buying materials without any formal specifications at all. This practice can lead to disastrous results.

A good example of what can happen is a handbag manufacturer who introduced a new handbag with a simple and conventional design: plastic sheet glued over a metal frame. The plastic used was obtained from a supplier with whom the manufacturer had been dealing for some time with satisfactory results.

One day the manufacturer started receiving complaints from a retail outlet: the plastic was letting loose from the metal frame. When other stores started to complain he sent several samples to our laboratories for evaluation. Analysis showed that in order to make a thin sheet of plastic the plastic supplier had added a considerable amount of plasticizer. At the temperature in the retail store the excess plasticizer bled out and combined with the latex of the adhesive to form a tacky mess. Accelerated testing at the early stages would have avoided this problem and produced a meaningful materials specification.

MORE ENGINEERING & DESIGN

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MATERIALS
IN DESIGN
ENGINEERING

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Win one of the 16 AWARDS for Best Use of Engineering Materials

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$500 and plaque

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Award Winners will be published. The award-winning entries will be published in the May Design Engineering Show Issue of **Materials in Design Engineering.** Some non-winning entries will also be published in subsequent issues and paid for at the usual rate.

To encourage sound, imaginative and progressive use of engineering materials in industrial and consumer products, **Materials in Design Engineering** each year sponsors an Awards Competition for Best Use of Engineering Materials. The entries in these annual competitions are reviewed by a distinguished board of judges.

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it's easy for you to enter...

here's how:

Simply select your best work of 1960

You can enter any part or product which you worked on, provided that: 1) You are employed in the product manufacturing industries, and 2) The design was completed during 1960 or the product went into production during 1960. An entry may be either a new product or a redesigned product that demonstrates sound, imaginative and progressive use of engineering materials. Engineering materials are defined as metals, nonmetallics, finishes and coatings, and material forms (such as castings, forgings, moldings, etc.). The product may be a complete assembly, a subassembly, a single part or a component.

Prepare your entry – it's easy

You need not write up your entry in the form of an article. Entries will not be judged for literary quality. See back page of this folder for details on the information that must be submitted with each entry.

Send in your entry by February 1

Entries must be mailed no later than February 1, 1961. Mail all entries to

Awards Editor
Materials in Design Engineering
430 Park Avenue
New York 22, New York

Here are last year's winners...

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A. Harder, B. Nozaki
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Randolph Research Co.
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T. Barabutes
Newark Meter Div.,
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General Electric Co.
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Component

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ENTRY FORM

ENTRY FORM

Materials in Design Engineering

5th ANNUAL AWARDS COMPETITION

for the Best Use of Engineering Materials

SPONSORED ANNUALLY BY MATERIALS IN DESIGN ENGINEERING • A REINHOLD PUBLICATION

Eligibility

Any person(s), department, group, or organization in the product manufacturing industries may submit an entry or entries. No one employed by a materials producer or supplier is eligible.

Preparation of Entries

1. The following information must be provided with each entry in order to allow the judges to make competent decisions:

a. A detailed description of the product including photographs or drawings. If the entry is a redesign, provide before and after illustrations if possible.

b. A description of requirements in service and/or fabrication that must be met by the product and the material.

c. A description of the previously used materials (if entry is a redesign).

d. A description of the material or materials selected for the product entry.

e. An explanation of why the material or materials were selected for the product. Describe the advantages or benefits gained through the choice. Back them up with evidence—facts, data, charts, tables on performance, quality or cost.

In general, entries should show that the materials selected for the product—

> Resulted in improved performance
> and/or lower costs or
> Best met the design and service requirements.

Here are a few ways in which a product can benefit from intelligent materials selection:

- Long service life
- Lower basic materials cost
- Less material required
- Improved appearance
- Permitted a new design
- Reduced production costs
- Improved service performance
- Reduced scrap
- Reduced or eliminated maintenance
- Permitted lower cost design
- Allowed greater design flexibility
- Simplified production and fabrication

Remember! The more detailed and documented your entry is, the more consideration it will receive from the judges.

2. Entries or portions of entries will not be returned unless requested. Entries should not include valuable papers or other material which must be returned, because there is always some danger of loss or mutilation. Whenever possible, photostats, photographs or other copies of such materials should be used instead.

3. All entries must be postmarked not later than **February 1, 1961.** The judges reserve the right to withhold awards at their discretion.

Publication of Entries

Materials in Design Engineering plans to publish articles on the winning entries and reserves the right to publish articles based on entries not winning awards.

NOTE: Please observe the rules given above. Use a separate blank for each entry; additional entry blanks available on request. Attach entry blank below, or its equivalent, to your entry and mail to:

Awards Editor, Materials in Design Engineering, 430 Park Ave., New York 22, N. Y.

Name ________________________________ Title ________________

Name(s) of person(s), group or organization who would receive award ________________________________

____

Company ____

Street address ____________________ City ____________ State ____________

Name or brief description of product being entered ________________________________

____

Was design (or redesign) of entry either completed or placed in production during 1960? ____________

Does your employer consent to entry under terms of this competition? ____________

Guide to Ferrous Castings

by Donald Peckner, *Associate Editor, Materials in Design Engineering*

ABOVE: DIFFERENTIAL HOUSING OF FORD FALCON IS CAST IN MALLEABLE IRON. FRONT COVER: 'MOON' SURFACE IS MAGNIFIED VIEW OF GRAY IRON SURFACE. CASTING FURNISHED COURTESY OF ACME TOOL CO., NEW YORK CITY.

Depending on the alloy selected, ferrous castings can offer outstanding strength; resistance to heat, corrosion or wear; mass; or magnetic properties. For some of you the text will be a concise introduction; for many a helpful review. But all engineers will find the accompanying standard data on all ferrous casting alloys, collected from many different sources, a valuable and convenient reference. The manual discusses:

- *The four main groups of alloys*
- *How to pick the right alloy for a particular service condition*
- *The principal molding and casting methods*
- *Designing ferrous castings*

Ferrous casting alloys present the design engineer and materials engineer with a broad spectrum of compositions which can be applied at temperatures ranging from cryogenic up to 2100 F. Mechanical and physical properties of the alloys cover a wide range: yield strengths, for example, can range from 20,000 psi up to 170,000 psi and modulus of elasticity from 12 × 10^6 psi up to 30 × 10^6 psi (see Table 1). This manual will introduce (or reintroduce) designers and materials engineers to the ferrous casting alloys, the casting processes, and the important design considerations. In addition, it presents specific property data in six important application areas. With this information, many engineers will have a firmer basis on which to discuss their problems with the foundryman. Even those who are more familiar with ferrous castings should find the comprehensive collection of data convenient as a ready reference source.

Working with the foundryman: the key to success

Obtaining castings is a simple task. Foundries, both captive and independent, are readily available to assist the designer and materials engineer in every part of the country. Because they are used so frequently and are a common industrial form, there is, perhaps, a tendency to regard castings with a feeling that, "Here is something that doesn't require a large expenditure of energy. Given a pattern and some sand, our needs can be fulfilled."

The giant advances in the foundry industry antiquate this approach to castings. New techniques, improved casting compositions, broad design information—all can be used by the foundry engineer to help designers and materials engineers obtain the castings they need. The quality of the castings will be better today than at any time in the past, and the broad research programs of the foundry industry hold promise of improving quality even further in the future.

Engineers responsible for obtaining castings should adopt the attitude that foundries be consulted before a design concept is frozen. To take full advantage of the casting process:

1. Design a component specifically as a casting rather than a conversion from other fabricating techniques.

2. In order to get the best material for the job, at the lowest cost, determine the full extent of the materials problem—what is really the end use of the casting, what environment will it operate in, etc.

3. Discuss the type of casting process to use with the foundry engineer before making a final decision. Often, a designer may feel that a particular casting process should be used. The foundry may resist his choice because from experience it can suggest more reasonable alternatives. Fig 1 shows a grid casting that was originally designed for the shell molding process. Clearances could not be maintained until the unit was cast in a green sand mold.

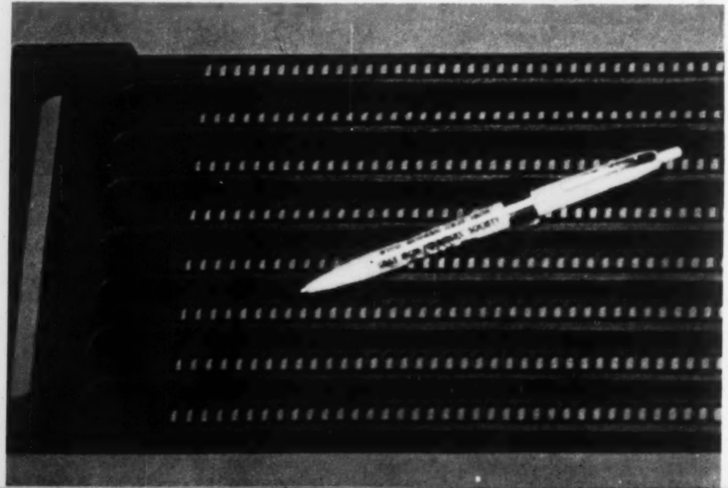
TABLE 1—GENERAL SURVEY OF SOME MECHANICAL AND PHYSICAL PROPERTIES OF CAST FERROUS ALLOYS

Type ➡	Gray Cast Iron	Malleable Irons	Ductile Iron	Carbon and Low Alloy Steel
Ten Str, 1000 psi	20-80	48-120	60-160	60-200
Yld Str, 1000 psi	15-60	30-95	40-135	30-170
Compr Str, 1000 psi	3-5 x ten str	48-95	40-135	60-200
Shear Str, psi	1-1.6 x ten str	~ 0.9 x ten str	0.9 x ten str	—
Elong (in 2 in.), %	0-3	1-26	1-26	5-35
Mod of Elast, 10^6 psi	12-22	25	24-26	30
Density (68 F), lb/in.^{3}	0.25-0.266	0.258-0.274	0.25-0.28	0.282-0.284
Coef of Ther Exp, 10^{-6} in./in.	5.8 (32-212 F)	6.6 (70-750 F)	7.5 (70-1100 F)	6.1-7.1 (90-415 F)
Elec Res (68 F), microhm-cm	75-120	28.8-34.4	55-70	14-17

Source: *Cast Metals Handbook*, American Foundrymen's Society, 1957.

1—*Originally designed for shell molding, this grid casting had to be switched to the green sand process. Shell mold could not maintain clearances; green sand had enough "give" to do job successfully.*

Gray Iron Founders' Soc.



Ferrous casting alloys: the four main groups

These alloys are generally grouped into four broad categories: cast irons (gray, white and high alloy), malleable irons (standard and pearlitic), ductile irons, and cast steels.

Relative ease of casting complex shapes ranges from simple to difficult in the following order: low strength gray iron, high strength gray iron, ductile iron, white iron, regular malleable iron, pearlitic malleable iron, carbon steel, very low carbon steel and high alloy steels.

1. Cast iron

Essentially an alloy of iron, carbon and silicon in which carbon is present in excess of the amount that can be retained in solid solution in austenite at the eutectic temperature. When cast iron contains one or more specially added elements in amounts sufficient to produce a measurable modification of the physical properties of the section under consideration, it is called alloy cast iron. Silicon, manganese, sulfur and phosphorus, as normally obtained from raw materials, are not considered alloy additions.

a. *Gray cast iron*—Cast iron which contains a relatively large percentage of its carbon in the form of graphite, and substantially all of the remaining carbon in the form of eutectoid carbide. The material has a gray fracture It offers excellent casting characteristics, low cost, good wear resistance and machinability, and excellent damping capacity. Its properties (Table 2) are dependent primarily on composition, and to some extent on cooling rate.

b. *White cast iron*—Cast iron in which substantially all of the carbon is present in the form of iron carbide. It has a white fracture.

c. *High alloy irons*—Irons containing sufficient alloy content (usually more than 3%) so that their properties are not characteristic of the regular irons. The various high alloy irons are generally used for the specific properties in which they are outstanding; i.e., corrosion resistance wear resistance or heat resistance

2. Malleable irons

Standard and pearlitic malleable irons offer a wide range of yield strengths (Table 3) combined with appreciable ductility. Properties can be precisely controlled by heat treatment. As a result, effect of section size is minimized.

a. *Standard malleable iron*—Obtained by a heat treatment of white cast iron which converts substantially all of the combined carbon into nodules of graphite

b. *Pearlitic malleable iron*—Obtained by a heat treatment of white cast iron which converts some of the combined graphite into graphite nodules but leaves a significant amount of combined carbon in the product.

TABLE 2—SUMMARY OF GRAY IRON SPECIFICATIONS

Specification ↓	Class	Min Tensile Str, psi	Brinell Hardness	Use
ASTM A190-47	—	—	—	Where strength and microstructure are not a prime requisite
ASTM A48-60	20	20,000	—	General castings not covered by other specifications and in which strength is a consideration
	25	25,000	—	↓
	30	30,000	—	
	35	35,000	—	
	40	40,000	—	
	45	45,000	—	
	50	50,000	—	
	60	60,000	—	
ASTM A159-55 SAE (Individual spec number given in Class column)	110	20,000[a]	187 max[a]	Automotive gray iron castings
	111	30,000[a]	170-223[a]	↓
	113	30,000[a]	179-229[a]	
	114	40,000[a]	207-269[a]	
	120	35,000[a]	187-241[a]	
	121	40,000[a]	202-255[a]	
	122	45,000[a]	217-269[a]	
ASTM A278-56	40[b]	40,000	—	Pressure-containing parts for use at 450 to 650 F[b]
	50	50,000	—	↓
	60	60,000	—	
ASTM A319-53[d]	I	Deliberately soft, low strength[c]	—	For superior thermal shock resistance ↓
	II	Above 30,000 may be expected[c]	—	For average thermal shock and moderate strength
	III	As high as 40,000 may be expected	—	For higher strength (at temperature)
U. S. Navy 46-1-9	—	25,000	120-180	High alloy scale-resisting castings ↓
U. S. Military MIL-G-858A	I	25,000	120-180	High alloy for resistance to corrosion, scaling, warpage and growth
	II	25,000	120-180	

[a] Properties in 1.2-in. dia test bar unless otherwise specified.

[b] Classes 20 through 35 are also covered but limited to use below 450 F.

[c] Low strength iron is desired for thermal shock resistance. Where strength is essential, tensile strength may be specified.

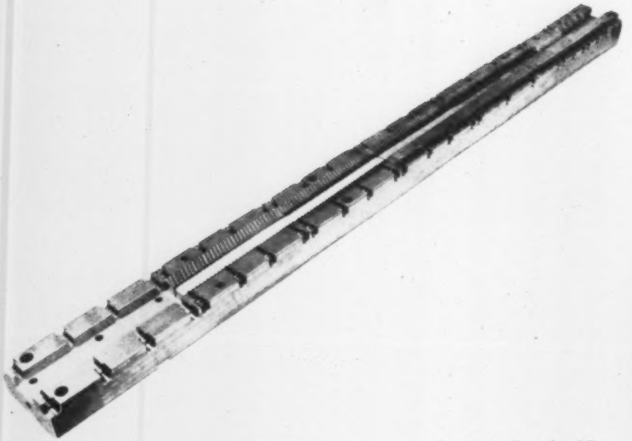
[d] Non-pressure-containing parts for elevated temperatures.

Source: Gray Iron Founders' Society.

3. Ductile iron

Similar in composition to gray iron. An innoculant, usually magnesium, permits formation of spherulitic graphite in place of the flake graphite found in gray iron.

Ductile and malleable irons actually fill the gap between gray

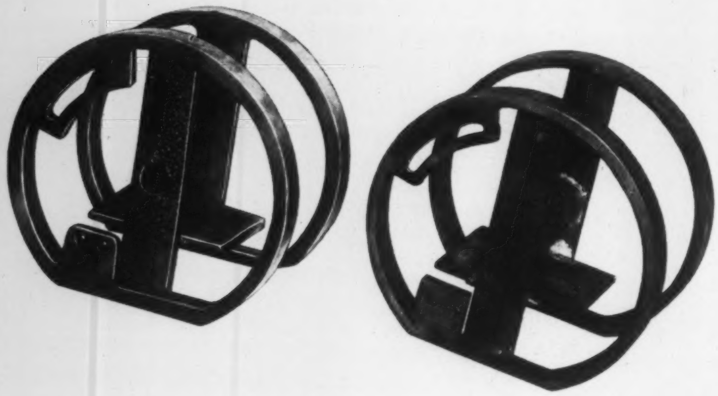


Gray Iron Founders' Soc.

Broach holder *used for finishing titanium air compressor blades was made more rigid by using a ductile iron casting (class 80-60-03).*

Malleable Founders' Soc.

Hose fitting *of malleable iron shown at left is swaged around rubber hose. Malleable castings can be easily and effectively cold formed.*



Gray Iron Founders' Soc.

Type cylinder *at left is gray cast iron. Substituting gray iron for welded fabrication (right) reduced costs 87% and increased machinability.*

TABLE 3—STANDARD AND PEARLITIC MALLEABLE IRONS (Minimum Mechanical Properties)

Grade ⬇	Ult Str, 1000 psi	Yld Str, 1000 psi	Elong (in 2 in.), %
STANDARD[a]			
32510	50	32.5	10
35018	53	35	18
PEARLITIC[b]			
45010	65	45	10
45007	68	45	7
48004	70	48	4
50007	75	50	7
53004	80	53	4
60003	80	60	3
80002	100	80	2

[a] Spec ASTM A47. [b] Spec ASTM A220.
Source: Malleable Founders' Society.

TABLE 4—STANDARD GRADES OF DUCTILE (NODULAR) IRON

Grade ⬇	Applicable Specifications	Mechanical Properties (min)		
		Ten Str, 1000 psi	Yld Str, 1000 psi	Elong (in 2 in.), %
60-45-10	ASTM A339-51T MIL-I-11466, Class 5	60	45	10
80-60-03	ASTM A339-51T MIL-I-11466, Class 4	80	60	3
100-70-03	MIL-I-11466, Class 2	100	70	3
120-90-02	MIL-I-11466, Class 1	120	90	2

Source: Gray Iron Founders' Society.

cast iron and steel. The mechanical properties of ductile iron (Table 4) are similar to those of pearlitic malleable irons. The difference between the two types is this: section size for ductile iron castings is not limited, as is the case with malleable iron. Soundness and casting properties of ductile iron are maintained even in heavier sections.

4. Cast steels

Alloys of iron, carbon and other alloying elements. Current specifications for cast steels are noted in Tables 5 to 7.

The large variation in properties of steel castings, as seen in these three tables, is made possible through control of the composition and by heat treatment. Steel castings are ductile and tough, as well as strong. In addition, the carbon and low alloy steels are freely weldable, a feature that is often important to designers and process engineers.

TABLE 5—CARBON AND LOW ALLOY CAST STEELS
(Minimum Mechanical Properties)

Spec	Class	Heat Treatment[a]	Tensile Strength, 1000 psi	Yield Point, 1000 psi	Elongation (in 2 in.), %
ASTM A27-58	N-2	A, N, NT, QT	—	—	—
↓	N-3	↓	—	—	—
	U-60-30		60	30	22
	60-30	A, N, NT, QT	60	30	24
	65-30	↓	65	30	20
	65-35		65	35[c]	24
	70-36		70	36	22
	70-40		70	40	22
ASTM A148-58	80-40	A, N, NT, QT	80	40	18
↓	80-50	↓	80	50	22
	90-60		90	60	20
	105-85		105	85	17
	120-95		120	95	14
	150-125		150	125	9
	175-145		175	145	6
ASTM A216-58T	WCA	A, NT	60	30	24
↓	WCB	↓	70	36	22
ASTM A217-58T	WC1	A, NT	65	35	24
↓	WC4	↓	70	40	20
	WC5		70	40	20
	WC6		70	40	20
	WC9		70	40	20
	C5		90	60	18
	C12		90	60	18
ASTM A352-58T	LCB[d]	N, NT, QT	65	35	24
↓	LC1[d]	↓	65	35	24
	LC2[d]		65	40	24
	LC3[d]		65	40	24
ASTM A356-58T	1	NT	70	36	20
↓	2	↓	65	35	22
	3		80	50	18
	4		90	60	16
	5		70	40	22
	6		70	45	22
	7		70	40	22
	8		80	50	18
	9		95	60	15
	10		85	55	20
ASTM A389-57T	C23	1850N + 1250T (min), 1 hr/in.	70	40	18
	C24	1850N + 1250T (min), 12 hr	80	50	15

[a] Alternate heat treatments listed. Key: A—full annealed; N—normalized; T—tempered; Q—liquid quenched.

[b] Hardness tests when specified in contract order.

[c] If full anneal specified, 33,000 psi yield required.

[d] Min Charpy keyhole impact notch of 15 ft-lb required at temperature specified by customer. Test temperatures and grades are: —50 F, LCB; —75 F, LC1; —100 F, LC2; —150 F, LC3

TABLE 6—CORROSION RESISTANT CAST STEELS
(Representative Mechanical Properties)

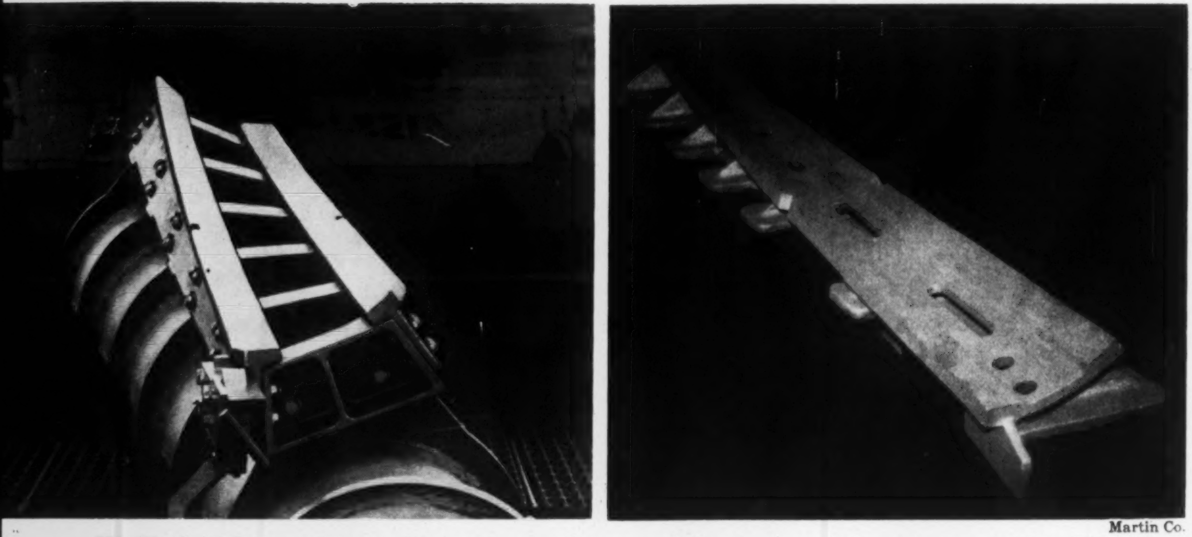
ACI Spec ↓	Ten Str, 1000 psi	Yld Pt, 1000 psi	Elong (in 2 in.), %
CA-15	200[a]	150	7
CA-40	220	165	1
CB-30	95[b]	60	15
CC-50	97[c]	65	18
CE-30	97[d]	63	18
CF-8	77[d]	37	55
CF-20	77[d]	36	50
CF-8M, CF-12M	80[d]	42	50
CF-8C	77[d]	38	39
CF-16	77[e]	40	52
CH-20	88[e]	50	38
CK-20	76[e]	38	37
CN-7M	69[e]	31	48
CF-3	77[e]	37	55
CF-3M	80[e]	42	50
CG-8M	82[e]	43	50
CD-4MCu	105[e]	85	25

Heat treatments: [a]Air cooled from 1800 F, tempered at 600 F; [b]annealed at 1450 F, furnace cooled to 1000 F, air cooled; [c]air cooled from 1800 F, tempered at 1400 F; [d]as cast; [e]water quenched from 2000 F.
Source: Alloy Casting Institute.

TABLE 7—HEAT RESISTANT CAST STEELS
(Representative Mechanical Properties)

ACI Spec ↓	Ten Str, 1000 psi	Yld Pt, 1000 psi	Elong (in 2 in.), %
HA	95	65	23
HC			
[a]	70	65	2
[b]	110	75	19
HD	85	48	15
HE	95	45	20
HF	85	45	35
HH	80	50	25
HI	80	45	12
HK	75	50	17
HL	82	52	19
HN	68	38	17
HT	70	40	10
HU	70	40	9
HW	68	36	4
HX	65	35	9

[a] Under 1% Ni, low N.
[b] Over 2% Ni, 0.15% N min.
Source: Alloy Casting Institute.



Martin Co.

Missile launcher, *a nine-part fabricated assembly, was redesigned as a casting, shown at right. The change increased dimensional stability and saved $1335 per launcher.*

Know the service conditions—then pick the material

Usually, a design has one limiting factor that governs the choice of casting alloy. At times the limiting factor is a simple one. Many castings are required simply to supply a large weight or accurately position a hole. In such cases the least expensive material, such as gray iron or plain carbon steel, can be chosen with expectations of successful performance.

At other times the engineer must decide on the need for heat resistance, ability to operate at low temperatures, ductility requirements, etc. In many instances the designer will find that one material will carry several burdens.

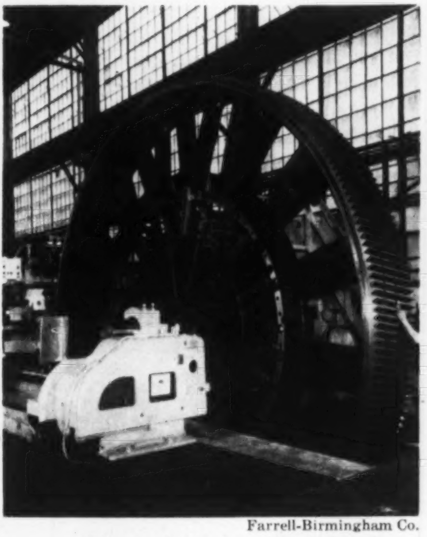
TABLE 8—HEAT RESISTING FERROUS ALLOYS
(Maximum Operating Temperature, F)

Cast Steel (low carbon)	600
Gray Cast Iron	600-750
White Cast Iron	600-750
Cast Steel (medium carbon)	700
Malleable Iron (all)	800
Ductile Iron	800
Cast Steel (low alloy)	1100
HA	1200
HF	1200-1600
HC	1200; 2000[a]
Gray Cast Iron + 1.5% Cr	1600
HD	1800
HL	1800
HH	2000
HE	2000
HU	2000
HW	2050
HN	2100
HT	2100
HX	2100
HK	2100
HI	2150

[a] For moderate load bearing service, 1200 F max; for oxidation resistance in high sulfur atmosphere, up to 2000 F.
Source: Alloy Casting Institute.

TABLE 9—STRESS-RUPTURE PROPERTIES OF SOME FERROUS CASTING ALLOYS
(100-Hr Rupture Stress, 1000 psi)

Temp, F ➡	800	1000	1200	1400	1600	1800	2000
HA	—	37	—	—	—	—	—
HC	—	—	—	3.3	1.7	0.85	—
HD	—	—	—	10	5	2.5	—
HE	—	—	30	11	5.3	2.5	—
HF	—	—	—	14	6.0	—	—
HH	—	—	—	14	6.4	—	1.5
HI	—	—	—	13	7.5	—	1.9
HK	—	—	—	14.5	7.8	—	2.5
HL	—	—	—	15.0	9.2	—	—
HN	—	—	—	—	9.5	—	2.5
HT	—	—	—	—	8.5	—	2.5
HU	—	—	—	15	8.0	—	—
HW	—	—	—	10	6	—	—
HX	—	—	—	13	6.7	—	1.7
Malleable Iron							
Standard	30.0	9.0	4.0	—	—	—	—
Pearlitic	32.5	15.0	—	—	—	—	—
Gray Cast Iron	42.5	24.6	4.5		—	—	
Ductile Iron							
80-60-30	47	17	4.3	—	—	—	—
60-45-10	32.5	10	3.3	—	—	—	—
Cast Steel							
Low Carbon	—	15	5	1.5	—	—	—
Low Alloy	68	41	—	—	—	—	—



Farrell-Birmingham Co.

Single helical split ring gear *is largest ever cast in alloy steel. Finished weight, 85,000 lb; diameter, 23 ft; face width, 30 in.*

TABLE 10—GENERAL CORROSION CHARACTERISTICS OF FERROUS CASTING ALLOYS

Gray Cast Iron	More res to some types of corr than carbon and low alloy steels, possibly because of graphite; e.g., cast iron soil pipe usually lasts longer than steel pipe. Res to strong sulfuric acid, cold conc phosphoric and nitric acids. Also res to many alkalis including sodium hydroxide, soda ash and ammonia
Malleable Iron	Res to atm corr in rural, industrial and marine environments, fresh and salt waters
Ductile (nodular) Irons	Approx same corr res as gray irons of similar comp
Cast Carbon and Low Alloy Steels	Corr characteristics approx the same as for wrought steels of same comp
CAST STAINLESS STEELS	
CA15, CA40	Good atm corr res. Excellent res to many organic media in rel mild svc
CB30	Res nitric acid, alkaline solutions, many organic chemicals, oxidizing atm up to 1400 F
CC-50	Excellent res to dil sulfuric acid in mine waters, mixed nitric and sulfuric acids, and oxidizing acids of all types
CE-30	Particularly res to sulfurous acid, mixtures of dil sulfuric and sulfurous acids, sulfuric and nitric acids, and sulfites
CF-8	Res strongly oxidizing media such as boiling nitric acid, sulfuric acid and sulfates, and organic acids
CF-20	Similar to CF-8 but used under less drastic condns
CF-8M, CF-12M	Res reducing media. More res to pitting corr than CF-8 in contact with chlorides. Not as res to boiling nitric acid as CF-8
CF-8C	Similar to CF-8
CF-16F	Similar, but somewhat inferior, to CF-8
CH-20	Res to hot dil sulfuric acid. Superior to CF-8 in certain media
CK-20	Similar to CH-20 but better res at elev temp
CN-7M	Res sulfuric acid and many reducing chemicals. Good res to dil hydrochloric acid and salt solutions
CF-3, CF-3M, CD-4MCu	Similar to CF-8
CG-8M	Similar to CF-8 but preferred in reducing environments
HIGH ALLOY CAST IRONS	
Ni-Resist	For many solutions, corr res is as good as, or better than, that of phosphor bronze
High Silicon Cast Iron	Good res to sulfuric and nitric acids at all conc and temp. Res to organic acids but inferior to gray iron in presence of alkalis
High Chromium Cast Iron	Excellent for oxidizing acids such as nitric acid. Reducing acids or presence of chlorides breaks down protective surface film. Practically immune to corrosion by aerated sea water and most mine waters

Source: *Materials Selector* issue, M/DE, Vol. 52, No. 6, to be published mid-Nov., '60.

This is particularly true in the area of heat and corrosion resistance.

When you need heat resistance . . .

This specification area requires careful examination. When exposure to elevated temperatures is involved, the tendency of the designer to over-specify is strong, even though the casting with the highest amount of alloy additions is not necessarily the best one for the job. For any given temperature range below 2150 F, a casting alloy can be chosen that will perform satisfactorily. The alloy may not perform well at slightly higher temperatures, but it is usually less expensive than alloys that offer the designer too great a safety factor. Over-specifying can become particularly costly when highly alloyed heat resistant steels or cast irons are specified for temperature ranges where gray iron or malleable iron will perform well.

Table 8 lists maximum service temperatures for ferrous casting alloys ranging from gray iron to the highly alloyed, heat resistant materials. In narrowing the choice of materials, two further points should be considered.

1. Operating temperature must be known with some degree of certainty. Occasional temperature excursions, if of short duration, may possibly be discounted. Metallurgical changes in ferrous alloys do not take place instantaneously but rather over a period of time.

2. Operating stress should be

TABLE 11—IMPACT PROPERTIES OF SOME CAST FERROUS ALLOYS BELOW ROOM TEMPERATURE

Material	Composition, %					Condn	Temp, F	Impact, ft-lb	
	Total C	Comb C	Si	Mn	Other			Charpy	Izod
Gray Cast Iron	3.42	1.07	1.2	0.5	—	As Cast	RT	14.5	—
							−4	13.5	—
							−112	12.1	—
Alloy Gray Cast Iron	2.76	—	2.0	—	Ni 1.7	As Cast	RT	—	44
							−45	—	38
	2.73	—	1.6	—	Ni 13.8, Cr 2, Cu 6	As Cast	RT	—	55[a]
							−45	—	50[a]
Malleable Cast Iron	3.05	—	0.8	0.5	—	Ann.	RT	4	—
							−51	3	—
							−78	3	—
Carbon Steel	—	0.14	0.4	0.7	—	Hard. and Temp	RT	38[b]	—
							−13	16[b]	
							−36	10[b]	
							−51	7[b]	
							−78	3[b]	
Mn-Mo Steel	—	0.33	0.6	1.4	Mo 0.3	Hard. and Temp	RT	30[c]	—
							−4	28[c]	—
							−40	28[c]	—
							−94	19[c]	—
							−148	15[c]	—
Cr-Mo Steel	—	0.30	0.3	0.7	Cr 0.8, Mo 0.2	Hard. and Temp	RT	43[c]	
							−4	38[c]	
							−49	38[c]	
							−94	29[c]	
							−184	17.5[c]	
Ni Steel		0.12	0.3	0.6	Ni 1.0	Norm. and Temp	RT	73[b]	
							−51	23[b]	
							−99	8[b]	
							−148	2[b]	
							−202	1[b]	
	—	0.10	—	0.7	Ni 2.5	As Cast	RT		72
							−114	—	17
	—	0.11	0.3	0.6	Ni 5.0	Norm. and Temp	RT	54[b]	
							−51	54[b]	
							−99	15[b]	
							−148	6[b]	
							−202	4[b]	
	—	0.13	0.25	0.80	Ni 9.0	Norm. and Temp	RT	44[c]	
							−108	41.4[c]	
							−314	22.6[c]	
Ni-Mo Steel	—	0.3	0.4	0.7	Ni 1.7, Mo 0.3	Norm.	RT	15[c]	
							−4	14[c]	
							−49	10[c]	
							−94	7[c]	
							−184	4[c]	
Ni-Cr Steel	—	0.26	0.4	0.7	Ni 1.1, Cr 0.7	Hard. and Temp	RT	24[c]	
							−4	22[c]	
							−94	14[c]	
							−184	8[c]	
Ni-Cr-Mo Steel		0.26	0.4	0.6	Ni 1.8, Cr 0.6, Mo 0.3	Hard. and Temp	RT	33[c]	
							−4	32[c]	
							−49	29[c]	
							−184	25[c]	

[a] Unnotched. [b] V-notch. [c] Keyhole notch.

carefully calculated so that creep rate or rupture strength can be determined. At elevated temperatures, especially, the effect of stress is deleterious if the ferrous casting alloy chosen has a high creep rate or low rupture strength at operating temperatures. Rupture stresses for ferrous alloys vary considerably, as shown in Table 9. If stress is very low, alloy can be chosen on the basis of oxidation resistance.

. . . corrosion resistance

This is another service requirement that often depends on intuitive judgment as well as specific data for a successful solution. Several parameters to consider:

1. Is surface finish a critical factor?
2. How important is corrosion outside the working area?
3. Must the casting maintain tight dimensional integrity over a long period of time?
4. Will corrosion products affect performance?

One item often overlooked in a corrosion situation is the thickness of the cast component. If the projected corrosion rate is not high, the mass of the casting may offset a supposed corrosion problem. In some cases, mass of the casting alone reduces the need for highly alloyed casting alloys. Although the corrosion rate may appear to be high, the large mass prevents effective degradation of properties.

Corrosion resistance of many ferrous casting alloys is summarized generally in Table 10. For example, if a casting must withstand atmospheric corrosion, malleable iron can be considered as well as ACI CA-15, an alloy compounded specifically for corrosion resistance. Each situation must be evaluated in terms of the environment so that satisfactory performance can be obtained at the lowest cost.

Behavior of several cast irons in particular corrosive environments is shown graphically in Fig 2. An interesting approach to the corrosion problem has been developed in Belgium by *Porbaix*.

TABLE 12—SEVERAL WEAR RESISTANT CAST IRONS

Type ⬇	Composition, %							Brinell Hardness Range
	C	Si	Mn	Ni	Cr	Cu	Mo	
Unalloyed Chilled	3.0-3.6	0.5-1.6	0.25-0.70	—	—	Tr	—	350-575
Unalloyed White	2.8-3.6	0.5-1.3	0.4-0.9	—	—	Tr	—	300-575
Ni-Hard	2.8-3.6	0.4-0.7	0.2-0.7	2.5-4.75	1.2-3.5	—	—	525-600
High Chromium	1.8-3.5	0.5-2.5	0.3-1.0	0-5.0	10.0-35.0	0-3.0	0-3.0	250-700
Molybdenum	1.7-3.7	0.3-2.6	0.2-1.5	0-5.0	0-6.0	0-1.5	0.3-12.0	350-700

Source: Gray Iron Founders' Soc.

Using pH value and potential as coordinates to represent the various chemical and electrochemical equilibria that affect corrosion, regions are determined in which immunity, corrosion or passivation may be predicted. A simplified Porbaix diagram for iron is shown in Fig 3.

. . . low temperature service

Principal requirement of ferrous castings intended for low temperature service is the ability to resist brittle fracture. The austenitic irons and steels will generally exhibit a low nil-ductility transition temperature (NDT) and can be used with confidence.

The most commonly used criterion for low temperature service is toughness, or ability to withstand shock loading. Table 11 shows composition and impact properties of many irons and steels at temperatures down to -300 F. These data indicate that many of the irons and plain carbon steels will be unsuitable for cryogenic applications. Low alloy cast steels should be given principal consideration because of their high impact strength at low temperatures.

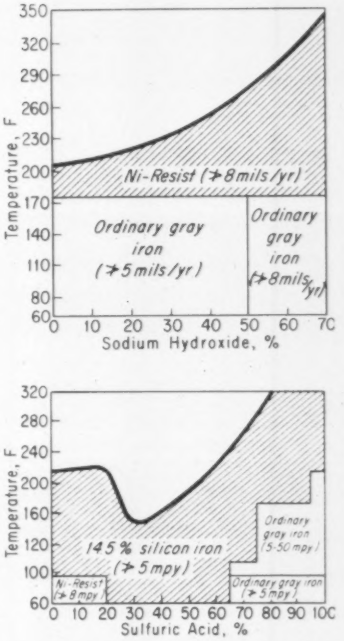
. . . wear resistance

Work hardening characteristics, high as-cast hardness, and heat treatability, although separate and distinct properties, offer the designer wide latitude in specifying materials for an application in which wear is the principal design criterion.

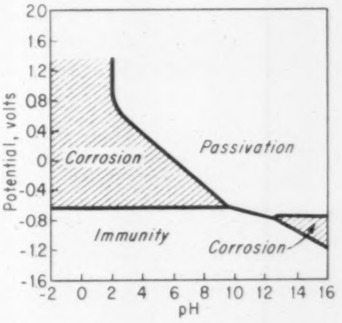
Ferrous parts can be cast virtually to size and heat treated in several ways: by through hardening, general surface hardening, or selective hardening of specified wear areas. Other parts can be hardened by the working action of the function they perform.

Many of the irons, especially white cast iron, have extremely wear resistant surfaces produced by chilling portions of the casting in the mold. Table 12 notes the composition of several wear resistant cast irons along with the surface hardness normally obtainable with each composition. Thus, the designer can consider several categories of material when wear resistance is required:

1. Hardness obtained as cast. Usually restricted to various cast iron compositions.
2. Hardness obtained by surface hardening. Cast carbon steels, gray irons, ductile irons and malleable irons can be used.
3. Hardness obtained by changing the surface chemically. Cast alloy steels are used in the carburized or nitrided condition.
4. Hardness obtained by heat treatment for uniform properties throughout the casting. The cast alloy steels, gray irons, ductile irons and malleable irons should be considered.
5. Hardness obtained through cold working of the casting surface. The alloy most often used in this case is austenitic manganese steel (Hadfield steel).



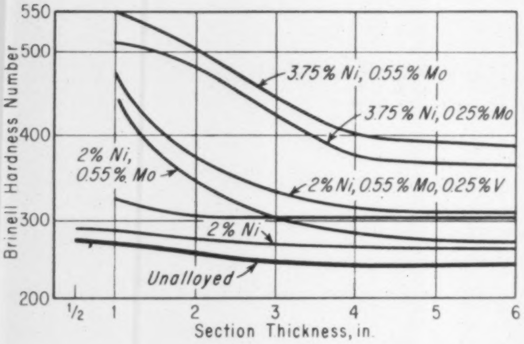
2—*Corrosion rates of cast iron in sodium hydroxide and sulfuric acid.* (British Cast Iron Research Assn.)



3—*Simplified* Porbaix *diagram for corrosion of iron at 77 F.* (As noted by U. R. Evans)

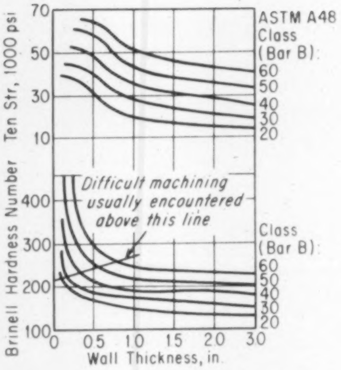
High strength

Ferrous castings offer the designer a convenient means to obtain high strength parts. Eliminating many of the fabricating problems can reduce costs and increase integrity. Because the heat treating characteristics of ferrous



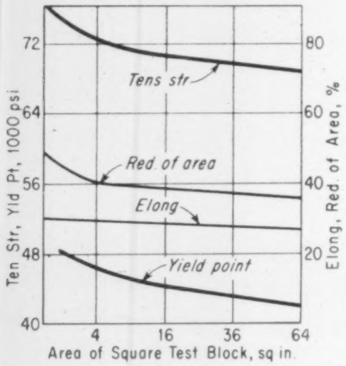
4—*Effect of alloy content and section thickness on the hardness of normalized ductile iron.*

(Isleib and Salvage, *Trans. AFS*, '57)



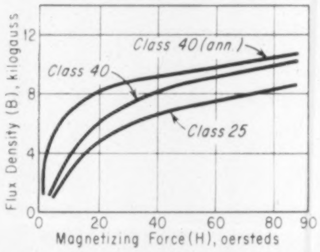
5—*Effect of section thickness on tensile strength and hardness of gray iron castings.*

(Gray Iron Founders' Soc.)



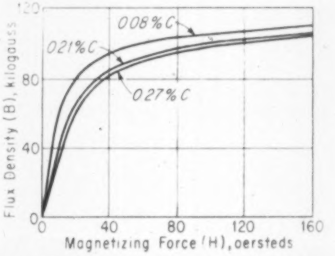
6—*Effect of mass on mechanical properties of an annealed medium carbon steel.*

(Steel Founders' Soc. of America)



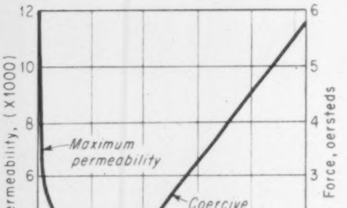
7—*Magnetization curves for several gray irons.*

(Gray Iron Founders' Soc.)



8—*Magnetization curves of annealed plain carbon steel castings.*

(National Bureau of Standards)



9—*Effect of carbon content on maximum permeability and coercive force of annealed carbon steel.*

(Adapted from Yenson)

casting alloys are well-known, the designer can expect to receive these castings with closely controlled mechanical properties. One potential stumbling block: the effect of section size. If this effect is not known precisely, it should be approximated to obtain reasonably realistic design properties. Fig 4, 5 and 6 show graphically the effect of section size for alloys ranging from gray cast iron to cast steel.

Pertinent mechanical properties of the ferrous casting alloys are summarized in Tables 2 to 5.

Magnetic properties

Although their magnetic properties do not approach those of the permanent magnet steels or the commonly used silicon steels, cast irons are widely used where magnetic properties are important. Some advantages are:

1. Iron castings can be made in intricate shapes where steel forgings would be impractical and steel castings difficult to obtain.
2. Magnetic properties of cast iron are less affected by tensile and compressive stresses than are those of steel.
3. Where cast iron has been permanently magnetized the temperature coefficient of loss in magnetism is much smaller than that of magnet steels. Shock losses are also small.
4. Nonmagnetic cast irons are used as structural members in electrical machinery and, because of their low permeability, reduce magnetic leakage.

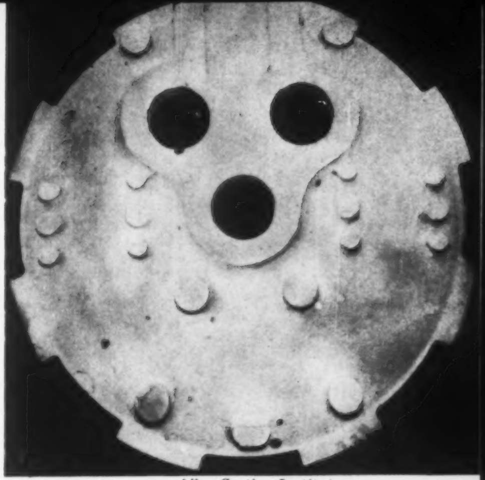
Cast steels are also used for magnetic circuits where a soft magnetic material is required. B-H curves for several grades of cast irons and steels are shown in Fig 7 and 8. Fig 9 shows the effect of carbon content on the magnetic properties of cast carbon steels.

The casting processes: how they differ

Choice of a casting process for producing ferrous castings is wide. Characteristics of the various processes are summarized and compared in Tables 13 and 14. Designers should be generally familiar with the capabilities and limitations of the processes in order to obtain better support from the foundry industry.

Green sand casting—Green sand molding is the method used most frequently. "Green" indicates that moisture is present in the sand and that the mold is neither dried nor baked. This method is not suitable for large or very heavy castings.

Dry sand casting—Most large and very heavy castings are made in dry sand molds. Mold surfaces are given a refractory coating and are dried before the mold is closed for pouring. The mold is thus hardened to provide the strength necessary to resist erosion by large amounts of metal. Manufacturing time is longer than



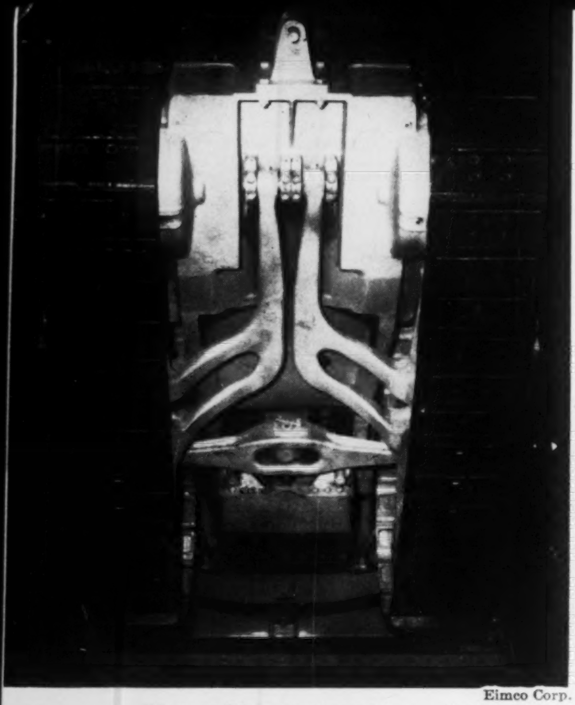
Alloy Casting Institute

Torpedo breech door *for nuclear submarine SS(N) 593,* Thresher, *is cast from ACI type CD-4M Cu precipitation hardening alloy. Casting weight, 250 lb; diameter, 26 in.*

TABLE 13—SUMMARY OF MOLDING AND CASTING PROCESSES

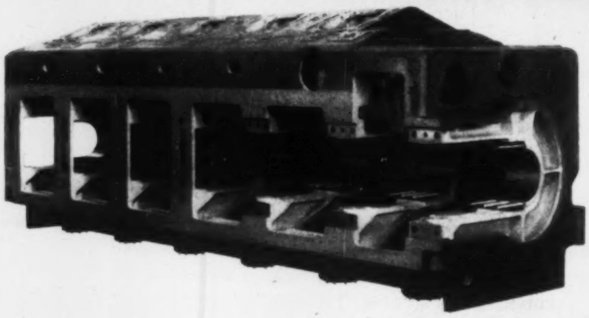
Process ➡	Green Sand	Dry Sand (oil sand)	Shell	Floor and Pit Molding	Permanent Mold	Investment	Centrifugal
Casting Size, Weight	1 oz to several tons	1 oz to several hundred pounds	1 oz to several hundred pounds	Large, any weight	Several ounces to about 25 lb	Less than 1 oz to several hundred pounds, usually under 10 lb	Up to several hundred pounds
Casting Intricacy External—Mold Surface	Limited by pattern drawing; no limit with cores	No limit	Limited by pattern drawing; no limit with cores	No limit with cores	Limited by casting ejection	Limited to wax patterns that can be ejected from dies	Casting of circular periphery most favorable for centrifugal casting. Any shape can be centrifuged
Internal—Cored Surfaces	No limit	No limit	No limit	No limit	No limit with sand cores	Limited to assemblies of wax patterns that can be ejected from dies	Hollow, circular unless centrifuged in a cored mold
Number of Castings Minimum	One	One	—	One	1000 to 5000	500 to 5000	One or more
Maximum	Pattern life limited	Core box life limited	Pattern life	Pattern life limited	Mold life limited, 1000 to 100,000	Pattern life	Pattern or mold life
Casting Alloys[a]	G, M, S, H&C	G, M, S, H&C	G, M, S, H&C	C, S, H&C	G, S	S, H&C	G, S, H&C
Tendency of Mold to Cause Tearing	Mold and cores can be made collapsible	Mold and cores are collapsible	Mold and cores are collapsible	Mold and cores can be made collapsible	Cores are collapsible	Not as collapsible as sand	
Type of Patterns	Simple wood patterns to machined metal patterns, core boxes	Core boxes and driers	Machines, metal patterns	Usually wood patterns	Machined mold	Metal die for casting wax patterns	Patterns for centrifuged castings. Metal mold for pipe castings or special equipment for making sand-lined pipe casting molds

[a] G—gray iron; M—malleable iron; S—steel; H&C—heat and corrosion resistant alloys.
Source: Adapted from American Foundrymen's Society.



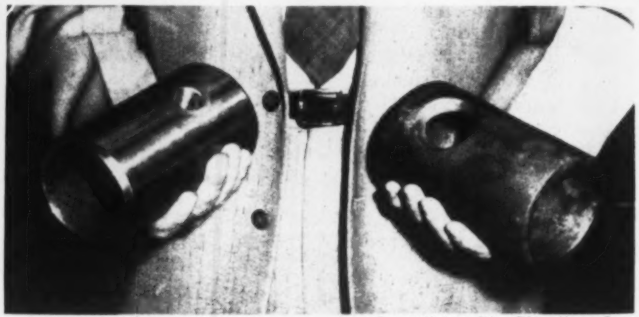
Eimco Corp.

Diagonal braces *in tractor are integrally cast with a track roller frame. The steel castings absorb impact loads. The design allows stresses to "flow" evenly throughout structure.*



Cooper-Bessemer Corp.

50,000-lb crankcase *for gas engine is cast in Meehanite.*



Copes-Vulcan Div., Blaw-Knox Co.

Retractable soot blowers *shell molded in ACI type HH alloy withstand 2300 F and thermal shock from high velocity steam.*

for green sand casting. Molds hardened by the CO_2 process are considered to be dry sand molds.

Core mold casting—Castings of unusual complexity (such as the thin, deep fins of an air-cooled engine cylinder) can be produced in a mold made from the type of sand commonly used for cores. The sand is almost free flowing when packed around the pattern and it fills crevices well to reproduce details. After baking, the mold is strong enough to resist erosion and breakdown by the flowing metal. This method can be considered when complexity requires more than one parting line to produce a casting.

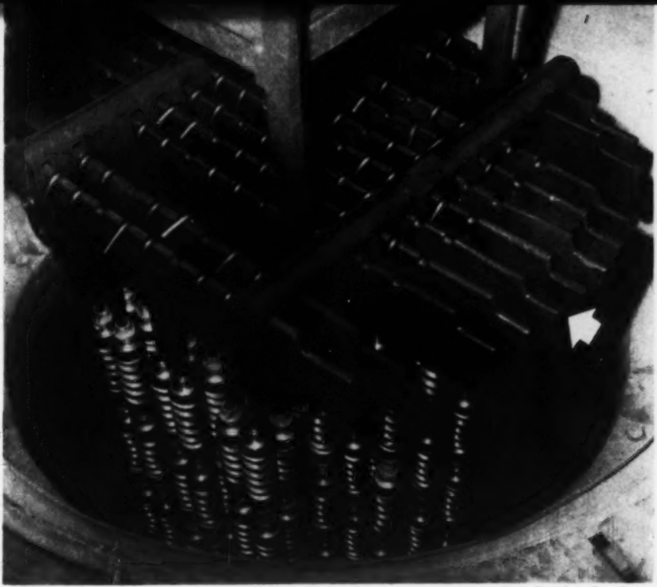
Shell mold casting—Molds are made by forming shells of resin-binded sand over a hot pattern and are suitable for small and some medium sized castings. The method provides: improved dimensional tolerances and surface finish, greater detail, and less draft than normally required by green sand process. Shell mold casting should be given particular consideration since it is a means for obtaining savings in machining and finishing of castings.

Permanent mold (gravity die) casting—Gray iron castings, within limits as to size, complexity and properties, can be produced in large numbers using mechanically operated permanent molds. This is a mechanized high production process. Such castings exhibit higher tensile strengths than gray iron castings poured in sand and shell molds because of the chilling effect of the metal mold.

Ceramic mold casting—Certain highly specialized castings requiring unusually fine finish, precise detail and close tolerances are produced in molds made of fired ceramics. The process is comparable to the plaster mold process used for nonferrous castings. Pattern equipment should be built to close dimensional tolerances and can be made of wood or metal. When the mold can be assembled in pieces, castings weighing up to 1500 lb and measuring several feet in major dimensions can be produced to relatively close tolerances.

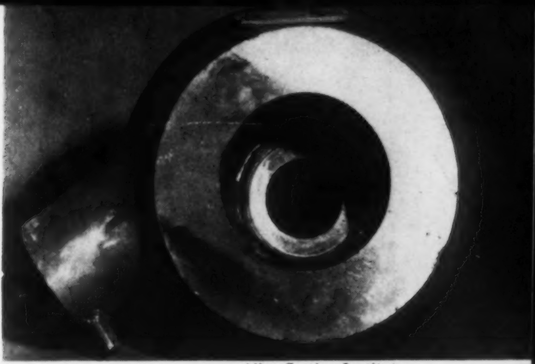
Investment casting—A wax pattern is invested in a refractory material and is burned out when the refractory is fired. No consideration of draft or parting line is necessary since the pattern can be formed by assembling a number of parts. Investment castings can be produced with excellent finish and detail, and to close tolerances, but the process is generally limited to castings weighing 100 lb max.

Centrifugal casting—This process is a means for producing a cavity in a casting without using a core. Pipe production by this process is well-known, but the method can be used for making other cylindrical castings such as engine cylinder liners and large process rolls. A second use: forcing metal into ceramic molds where the high metal surface tension and low permeability of the mold material may not allow complete filling of the mold by gravity alone.



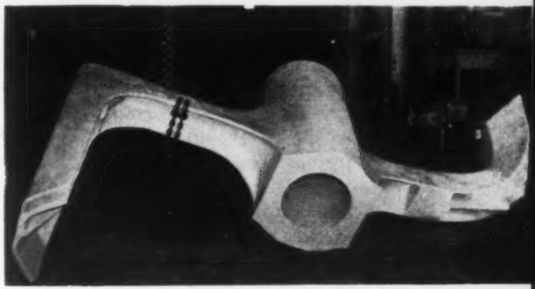
Alloy Casting Institute

Heat treating fixture *of type HT alloy iron is used to suspend steering cams in carburizing furnace. Alloy withstands thermal shock and carburizing atmosphere.*



Alloy Casting Institute

Volute casing *used in nuclear power plant of* N. S. Savannah *is cast in CF-8 alloy. Casing weighs 3150 lb.*



General Steel Castings Corp.

Cast steel stern frame *for single screw cargo vessels. Rough weight, 79,250 lb; height, 25 ft, 6 in.; length, 22 ft; width, 4 ft, 6 in.*

TABLE 14—EFFECT OF MOLDING METHOD ON DIMENSIONAL CHARACTERISTIC OF CASTINGS

Process ➡	Green Sand—General	Green Sand—Optimum	Dry Sand	Shell	Permanent Mold	Investment
Tolerances Average ±	Gray irons, 3/64 in./ft; malleable irons, 1/32 in./ft.; steel, 1/16 in./ft	0.005 in./in. As little as 0.005 in. total on some casting dimensions	Similar to or better than green sand	0.005 in./in. As little as 0.003 in. total on some dimensions	0.015 in./in. for first inch. Add 0.001-0.002 for each added inch. May be cut to ± 0.010 in. total in some castings	Min 0.004 in./in. Avg 0.005 in./in. on dimensions over 1 in.
Across Parting Line	Included in above values	Add 0.010 in. to above	—	Add 0.005-0.015 in. to above	Add 0.010-0.020 in. to above	Add 0.001 in./in. to above
Surface Finish, μin. rms	250-1000	100-250	Somewhat better than green sand	50-250	100-250	10-85
Section Thickness, in. Minimum	Gray irons, 1/8 in.; malleable irons, 1/8 in.; steel, 1/4-1/2 in.	Same as green sand	Same as green sand	Same as green sand	Gray iron, 3/16 in.	0.025-0.050 in. depending on surface area of the section
Maximum	No limit in floor or pit molds	—	—	—	2.0 in.	Normally 0.500 in.; may be more in some cases
Min Cored Hole Dia, in.	1/4 in.	3/16 in.	3/16-1/4 in.	1/8-1/4 in.	3/16-1/2 in.	0.020-0.050 in. dia.
Chilling Power[a]	1.0	1.0	0.2-1.0	0.2-1.0	200-500	1.0 (mold is heated)

[a] Relative to green sand.
Source: Adapted from American Foundrymen's Soc.

Designing ferrous castings

The rules of thumb outlined in this section may seem commonplace to some readers. We suspect, however, that many others will be encountering some (or all) of them for the first time. This section of the manual was written after replies were received to a questionnaire sent to ferrous foundries all over the country and ranging in size from large to small. Throughout the country foundrymen seem to have a universal complaint: designers are not following simple design rules which make the foundryman's job easier and reduce the casting costs of the purchaser. This situation should improve in the future as the foundryman and designer come to recognize each other's problems.

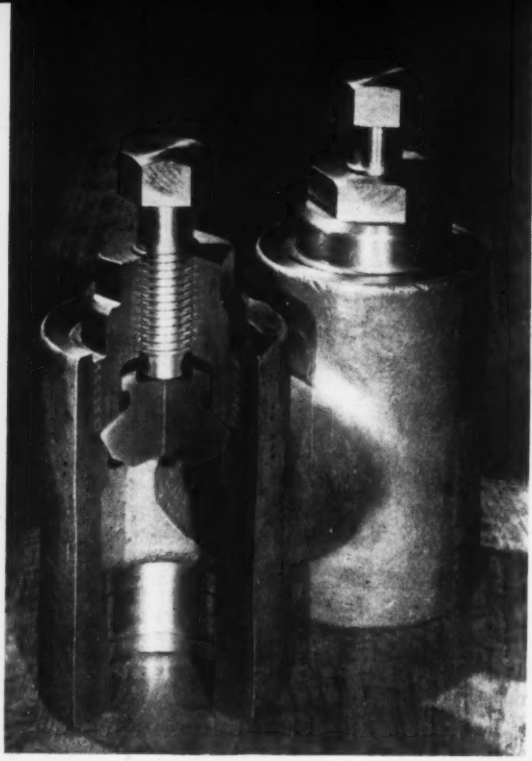
The designer holds the real key to lower casting cost. Proper recognition of factors that lead to good casting design *before* a design is frozen will reduce problems encountered after the patterns are made. Probably the one rule underlying all design considerations is that it is much more simple and less expensive to revise a drawing than it is to modify a pattern. Reducing the number of castings rejected because of inherent casting defects or eliminating unneeded weight in the form of risers or excessive thickness is good design practice. A foundry quotation is based not only on the weight of metal shipped but also on the weight returned to the scrapbin.

Here are nine simple design rules that apply to all ferrous castings:

1. Work closely with the foundryman.

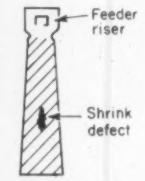
Early consultation between the designer and foundryman will eliminate obvious foundry problems and help in the solution of unexpected ones. Designing a casting which is a practical achievement, rather than a challenge to the foundryman's skill and ingenuity, is a serious matter. Foundrymen can answer many questions normally considered beyond the design engineer's purview: type of pattern needed, expected metal shrinkage, best molding method to consider, conditions necessary to make a dependable casting, machine finish, and dimensional limitations.

Since few engineers *or* foundrymen can follow all section changes from a blueprint, a three dimensional drawing or small model of the casting will permit a detailed study of such problems as: how will the metal enter the mold, how will solidification proceed, how must cores be designed and placed, what parts of the casting require risers to insure a sound casting, where may shrinkage or cracking be expected. Other questions that can be answered range from proper placement of gates and risers to probable cost and delivery.



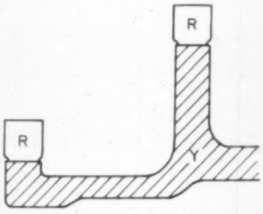
Alloy Casting Institute

Header bodies *cast in CF-8 alloy resist extremely corrosive conditions encountered in refining crude oil at high temperatures and pressures.*



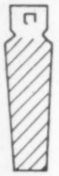
INCORRECT

Light section at top prevents feeding

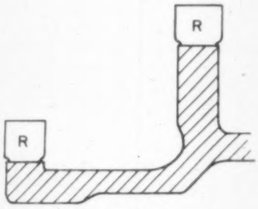


INCORRECT

Risers at R will not feed Y



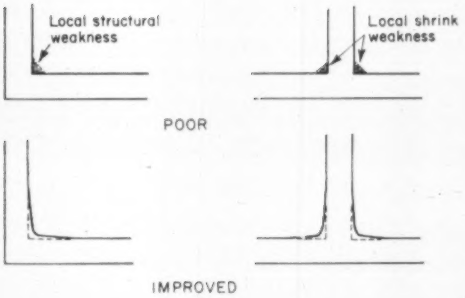
CORRECT

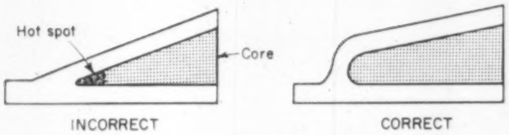


IMPROVED

2. Design for casting soundness.

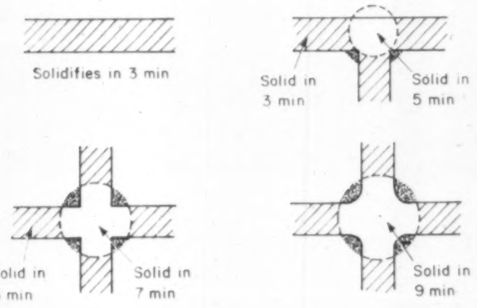
Since most ferrous casting alloys shrink during solidification, directional solidification and correct location of risers can be used to promote casting soundness. Whenever possible, thinner sections should be allowed to solidify first so that the heavier sections can act as a metal source during solidification. The heavier sections themselves can be fed by a riser. Attempting to feed a heavy section through a thinner one will always result in shrinkage porosity since the thin section solidifies first and chokes off the metal supply flowing to the heavier one.

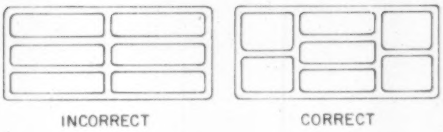

Local structural weakness
Local shrink weakness
POOR
IMPROVED

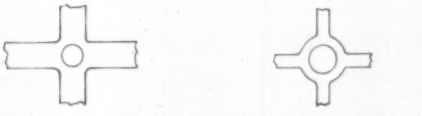

Hot spot
Core
INCORRECT
CORRECT

3. Avoid sharp angles and corners to eliminate hot spots.

To properly design adjoining sections, replace all sharp angles with radii. Eliminate sharp reentrant angles to eliminate heat concentration (hot spots).


Solidifies in 3 min
Solid in 3 min
Solid in 5 min
Solid in 3 min
Solid in 7 min
Solid in 9 min


INCORRECT
CORRECT

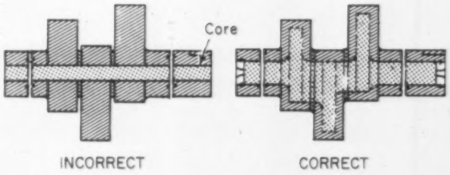


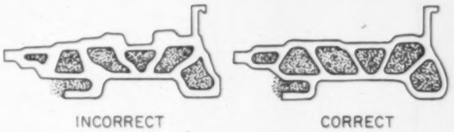
Cored hole speeds solidification

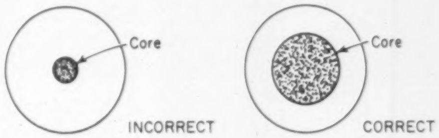
Circular web is preferred

4. Bring the minimum number of sections together

The accompanying illustrations show very simply the degrading effect of joining many sections. The problem, when a design necessity, can be attacked by adequate coring or addition of webbing where the sections join.

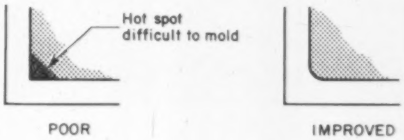

Core
INCORRECT
CORRECT

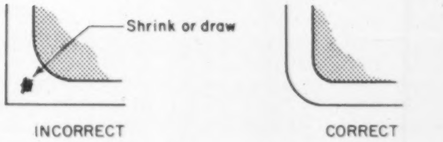

INCORRECT
CORRECT


Core
Core
INCORRECT
CORRECT

5. Keep thickness as uniform as possible.

Joining sections of nonuniform thickness creates the problem of excessive porosity. It can be corrected by using proper coring technique or improving design to eliminate the thickness difference. The maximum range of thickness after proper blending should be no greater than 4-5:1. The i.d. of cylinders and bushings should exceed the wall thickness of the casting. When this is not possible, it is safer to cast the component as a solid and drill the required hole.


Hot spot difficult to mold
POOR
IMPROVED


Shrink or draw
INCORRECT
CORRECT

Fillet too large; causes shrinkage or weak metal structure

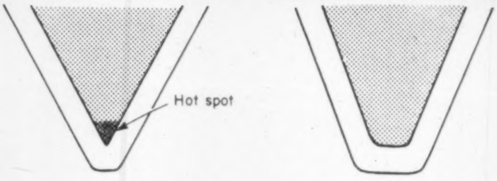
Uniform cooling rate obtained

6. Use fillets.

Fillets have several functions. They help to: reduce stress concentrations in the casting; eliminate cracks and tears at re-entry angles; make corners more moldable; and eliminate hot spots.

7. Give angular forms an ample radius.

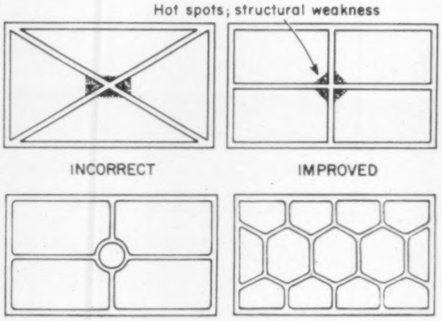
Allow a generous radius to eliminate hot spots in angular sections (such as V or Y sections):

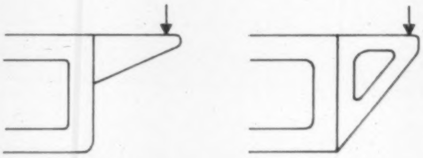


8. Design ribs and brackets for maximum effectiveness.

Ribs can increase stiffness and reduce weight. If too shallow in depth or too widely spaced, they are not effective. In designing the rib, reduce hot spot possibility by avoiding a local accumulation of metal. As pointed out in Rule 3, acute angles should be avoided. Therefore, the examples of poor and good rib design shown below are self-explanatory.

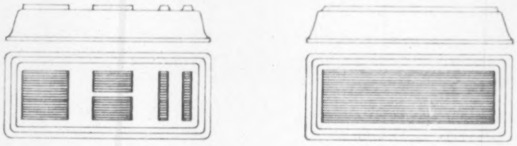
Brackets can be considered from two points of view. In the first, the bracket is cast separately and attached later to the main structure. This helps reduce manufacturing costs. When this approach cannot be used, make the length of contact with the main casting as ample as possible and provide the correct fillets to avoid hot spots and stress concentrations.

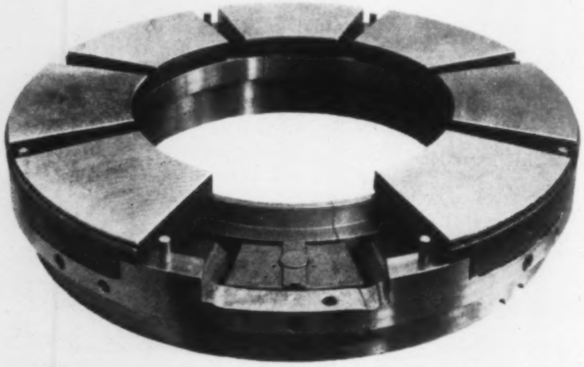




9. Do not use bosses, lugs and pads unless absolutely necessary.

Bosses, lugs and pads increase metal thickness and create hot spots. Except when casting gray or ductile iron, a lug should not be used when a similar surface can be obtained by milling or countersinking. When several lugs and bosses are located on one surface, they should be joined to facilitate machining.





Treadwell Engineering Co.

Kingsbury thrust bearing *for marine propeller shaft. Weight, 1580 lb; outside diameter, 47 in.*

Acknowledgment

The author would particularly like to thank Charles Walton, Gray Iron Founders' Society, and John Weaver, Waukesha Foundry, for reviewing the manuscript. Frederic Benz, Meehanite Metal Corp., supplied the information on casting design. Assistance of the following companies and societies is also gratefully acknowledged:

Allegheny Ludlum Steel Corp.
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Cooper-Bessemer Corp.
Dayton Foundry
Eaton Mfg. Co.
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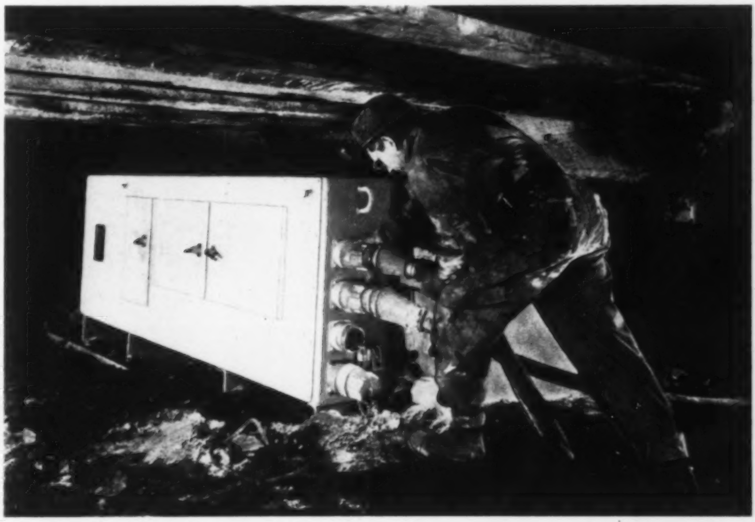
Dow Corning
SILICONE NEWS
for design and development engineers • No. 78

Keeps Your Feet Dry

Shoe Saver®, the water repellent that protects and preserves leather footwear, is one very popular member of the silicone family.

"Field" engineers swear by it for hunting boots and golf shoes. "Domestic" engineers marvel at the way it keeps dress shoes soft, comfortable, and new looking longer. "Little League" engineers like the way it keeps shoes from getting soaked through when puddle widths are misgauged.

Use Shoe Saver to protect your family's footwear this fall and winter. Available in spray can or dauber bottle at most sporting goods counters, shoe stores or shoe repair shops. *No. 241*



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Westinghouse engineers have made excellent use of the advantage silicone insulation provides . . . to increase capacity of mine power centers without a corresponding increase in size or weight. Constructed for rugged service, the new power centers are better able to meet demand, can readily be skidded from one location to another, and are more easily stored when not in service.

The silicone-insulated power centers deliver nearly 50% more power per pound of transformer than units of comparable size insulated with Class A or B insulating materials. The 600-kva, 7200 480-volt unit is only 42 inches high, the 300-kva unit, only 36 inches. Both units handle increasing loads without sacrificing portability or space vitally important in mining operations.

Silicone insulation helps the power centers withstand the most severe dust and moisture conditions likely to be encountered underground. Sealed in a nitrogen-filled enclosure, the coils are protected against moisture even when de-energized during prolonged shutdowns. The power centers are virtually maintenance-free.

For a full report on all the cost-saving and performance advantages that Dow Corning silicone insulation gives motors, generators, transformers and other electrical equipment, circle . . . . . . *No. 242*

SOLVE SPACE AGE PROBLEMS

How? "With silicones" has been the byword in the aircraft industry for a number of years — and still is. How extensively so is indicated in the new documentary reference, "Silicones Solve Space Age Problems".

Constant new advances in technology of aeronautics have created more severe performance requirements . . . have stimulated development of new silicones and new applications for established silicones.

Now available, this new bulletin for aeronautical engineers and designers is a compilation of concise case histories that show the wide range of uses of silicones. It suggests possible design changes and solutions to problems through the advantageous use of the different forms of silicones.

Included are histories that cite how Dow Corning Silicones have been *(Cont. pg. 2)*

SILICONES
SOLVE SPACE AGE PROBLEMS

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE OR REFERENCE NUMBER ON READER SERVICE CARD

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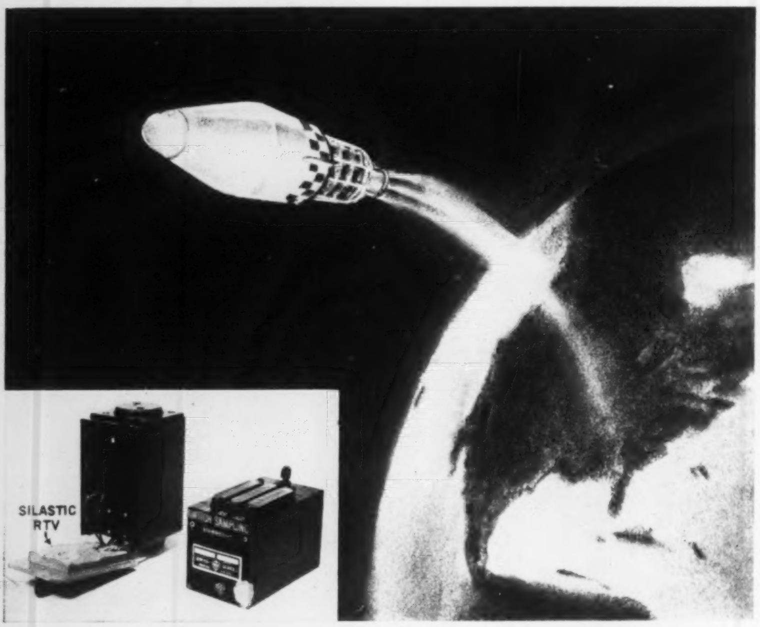

HOW TO MEET TOUGH SPECS

Missile-making calls for materials and components that will meet the most rigid environmental specifications. That frequently means silicones to engineers at General Devices, Inc., Princeton, N. J.

Here's a good example. Every Discoverer rocket that leaves the ground carries with it General Devices' CM Series Minicom Type Electromechanical Commutators. To assure optimum protection against moisture and vibration, Commutator connector heads are coated with Silastic® RTV, Dow Corning's fluid silicone rubber that vulcanizes at room temperature.

This job-proved "form-in-place" silicone rubber provides components and wiring with more than ample protection against 100% relative humidity for 72 hours or more. It provides a resilient cushion that enables sensitive parts to withstand 100 G shocks for 5 milliseconds . . . permits continuous operation despite vibrations of 30 to 50 G's over a frequency range of 25 to 2,000 cps in each of three mutually perpendicular planes.

Silastic RTV readily flows around the most intricate parts to provide a void-free, moistureproof seal of high dielectric strength. Its ease of handling and the unique properties it provides has led General Devices to make extensive use of Silastic RTV for component boards and potted connectors for their multichannel telemetering equipment. Other Silastic RTV uses are in their telemetric and electronic high speed switches, multicoders and multiplexers, keyers, power supplies, subcarrier oscillators, telemetering and data logging equipment. *No. 243*

SPACE AGE PROBLEMS *(Continued)*

used to increase reliability of commercial and military aircraft, of ground support and avionic equipment. A "capsuled" table summarizes the more important properties of the different silicones, designates typical applications of each.

To obtain your free copy, circle *No. 244*

new literature and technical data on silicones

Transparent Potting Compound — Dow Corning Dielectric Gel is the silicone potting material that flows as a water-white fluid and cures in place to form a clear, resilient, protective mass that permits both visual and instrument checking of parts within a potted assembly. Retention of outstanding dielectric properties, moisture resistance and serviceability over a wide temperature span are some of the features of this unique potting material described in a four-page, illustrated brochure. *No. 245*

◆

SILASTIC
WIRE & CABLE INSULATION

Wire and Cable insulated with Silastic is used to advantage in numerous ways in different industries. A new, six-page illustrated brochure details the outstanding electrical properties, serviceability over a temperature span from —90 to 260 C and resistance to the effects of weathering, corona, ozone and nuclear radiation of wire and cable insulated with Silastic . . . cites applications and specifications ranging from aircraft to commercial building, from shipboard to appliances. *No. 246*

◆

Optical Silicon Reference — Physical properties and transmission characteristics of Dow Corning optical silicon are presented with the aid of a table of typical values and nine full-page graphs. All the features that make optical silicon useful for infrared detection, surveillance and guidance systems are contained in a new multi-page technical data sheet. *No. 247*

◆

Something to Consider — Silicone molding compounds produce parts and components having a highly desirable combination of structural and dielectric properties — heat stability, high strength, good retention of insulation value, low moisture absorption, good thermal conductivity, light weight, and resistance to corrosion and fungus attack. Properties and applications are presented in a four-page leaflet. *No. 248*

◆

Job-proved Dow Corning silicone lubricants help designers solve lubrication problems created by adverse operating conditions. Used on equipment ranging from freezers to core oven conveyors —at temperatures as low as minus 100 F, as high as 500 F. Send for a handy brochure on properties and applications. *No. 249*

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FILE FACTS

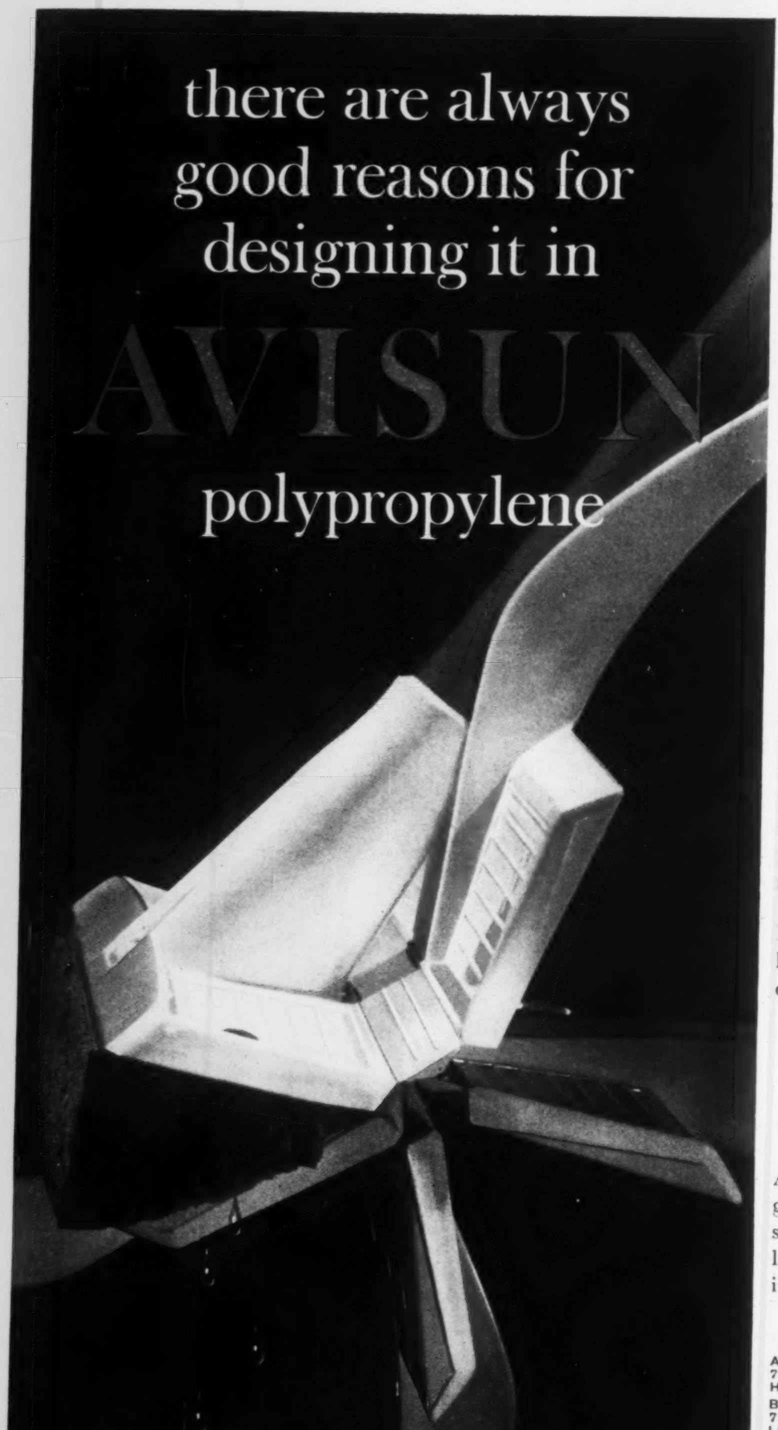
Maximum Torque Values for Fasteners of Seven Materials[a]

Bolt Size	Low Carbon Steel[b]	304 Stainless Steel	Brass	Silicon Bronze	Aluminum 2024-T4	316 Stainless Steel	Monel
TORQUES IN IN-LB							
2-56	2.2	2.5	2.0	2.3	1.4	2.6	2.5
2-64	2.7	3.0	2.5	2.8	1.7	3.2	3.1
3-48	3.5	3.9	3.2	3.6	2.1	4.0	4.0
3-56	4.0	4.4	3.6	4.1	2.4	4.6	4.5
4-40	4.7	5.2	4.3	4.8	2.9	5.5	5.3
4-48	5.9	6.6	5.4	6.1	3.6	6.9	6.7
5-40	6.9	7.7	6.3	7.1	4.2	8.1	7.8
5-44	8.5	9.4	7.7	8.7	5.1	9.8	9.6
6-32	8.7	9.6	7.9	8.9	5.3	10.1	9.8
6-40	10.9	12.1	9.9	11.2	6.6	12.7	12.3
8-32	17.8	19.8	16.2	18.4	10.8	20.7	20.2
8-36	19.8	22.0	18.0	20.4	12.0	23.0	22.4
10-24	20.8	22.8	18.6	21.2	13.8	23.8	25.9
10-32	29.7	31.7	25.9	29.3	19.2	33.1	34.9
¼-20	65.0	75.2	61.5	68.8	45.6	78.8	85.3
¼-28	90.0	94.0	77.0	87.0	57.0	99.0	106.0
⁵⁄₁₆-18	129	132	107	123	80	138	149
⁵⁄₁₆-24	139	142	116	131	86	147	160
⅜-16	212	236	192	219	143	247	266
⅜-24	232	259	212	240	157	271	294
⁷⁄₁₆-14	338	376	317	349	228	393	427
⁷⁄₁₆-20	361	400	327	371	242	418	451
½-13	465	517	422	480	313	542	584
½-20	487	541	443	502	328	565	613
⁹⁄₁₆-12	613	682	558	632	413	713	774
⁹⁄₁₆-18	668	752	615	697	456	787	855
⅝-11	1000	1110	907	1030	715	1160	1330
⅝-18	1140	1244	1016	1154	798	1301	1482
¾-10	1259	1530	1249	1416	980	1582	1832
¾-16	1230	1490	1220	1382	958	1558	1790
⅞-9	1919	2328	1905	2140	1495	2430	2775
⅞-14	1911	2318	1895	2130	1490	2420	2755
1-8	2832	3440	2815	3185	2205	3595	4130
1-14	2562	3110	2545	2885	1995	3250	3730
TORQUES IN FT-LB							
1⅛-7	340	413	337	383	265	432	499
1⅛-12	322	390	318	361	251	408	470
1¼-7	432	523	428	485	336	546	627
1¼-12	396	480	394	447	308	504	575
1½-6	732	888	727	822	570	930	1064
1½-12	579	703	575	651	450	732	840

[a] Values in this table are intended as a guide only; the many variables make exact figures impossible.

[b] Grade C-1010 for sizes No. 10 and below; C-1018 for ¼ through ⅝ in.; alloy of C-1020 and C-1035 for larger sizes.

Courtesy Industrial Fasteners Institute



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it's the Self-Hinge

Polypropylene is, tough . . . so tough that self-hinges, like the one shown in the stop-action photograph at the left, are perfectly practical. Polypropylene's low cost and manufacturing economies have enabled O-Cedar to enter a new price area with this durable, quality mop. Retail price is only $1.98.

Polypropylene makes better products at lower cost. No other material has this combination of properties:

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MATERIALS AT WORK

...AT A GLANCE

Strontium-90 power generators may someday be simple, reliable, long time sources of electrical energy. The proposed generators would consist of strontium titanate pellets tightly sealed within three layers of Hastelloy C. Heat produced by normal radioactive decay in about 1 lb of the compound could be converted directly into 5 w of continuous electrical energy by a series of thermoelectric elements surrounding the fuel capsules. The unit could operate without maintenance or refueling for several years.

Source: Martin Co., Nuclear Div., Baltimore 3.

Glass-reinforced Teflon piston rings were found to be superior to all other materials tested for use in jet engine starting systems. The manufacturer's selection of the material was based on its ability to retain strength and self-lubricating properties under operating temperatures of 545-595 F and pressures of 145 psi.

Source: Rogers Corp., Rogers, Conn.; piston rings fabricated by Janitrol Aircraft Div., Midland-Ross Corp.

A new four-cylinder engine using a stainless steel block is said to develop more power for its weight than any automobile engine now available. The engine, to be used initially in boats, and sports and racing cars, incorporates 40 lb of stainless to provide "rapid and uniform heat dissipation, good strength, low weight and corrosion resistance." The 175-hp engine weighs only 175 lb and occupies 125 cu in. of space.

Source: Committee of Stainless Steel Producers, American Iron & Steel Institute, 60 E. 42nd St., New York 17.

The nerve-wracking screech of chalk across a blackboard may be a thing of the past—thanks to a new vinyl chalkboard surfacing material. The colorful baked-on finish (blue, green, black) can be applied to any steel panel for use in offices and schools.

Source: John L. Armitage Co., 230 Park Ave., New York 17; boards manufactured by Virginia Metal Products, Inc.; vinyl resins produced by Union Carbide Plastics Co.

Beryllium parts for precision gyros are said to be "significantly superior to any other material." Here's why: they are as light as magnesium, have a modulus of elasticity 50% greater than that of steel, retain structural strength at temperatures above the melting temperatures of aluminum and magnesium, have the same electrical and thermal conductivity as aluminum, corrosion resistance, and a coefficient of thermal expansion almost equal to that of alloy steel. Some gyro parts made of beryllium include spin motors and rotor bearings.

Source: Sperry Gyroscope Co., Great Neck, L.I., N.Y.

The successful switch from steel to titanium rocket motor casings may add significantly to the range of the Air Force's Minuteman ICBM. The casing, which is used on the third-stage rocket motor, is made entirely of titanium and weighs about one-third less than conventional steel casings. The titanium casing withstood a static test firing so well that it will be cleaned, reloaded with solid propellant and used again.

Source: Aerojet-General Corp., 11711 S. Woodruff Ave., Downey, Calif.

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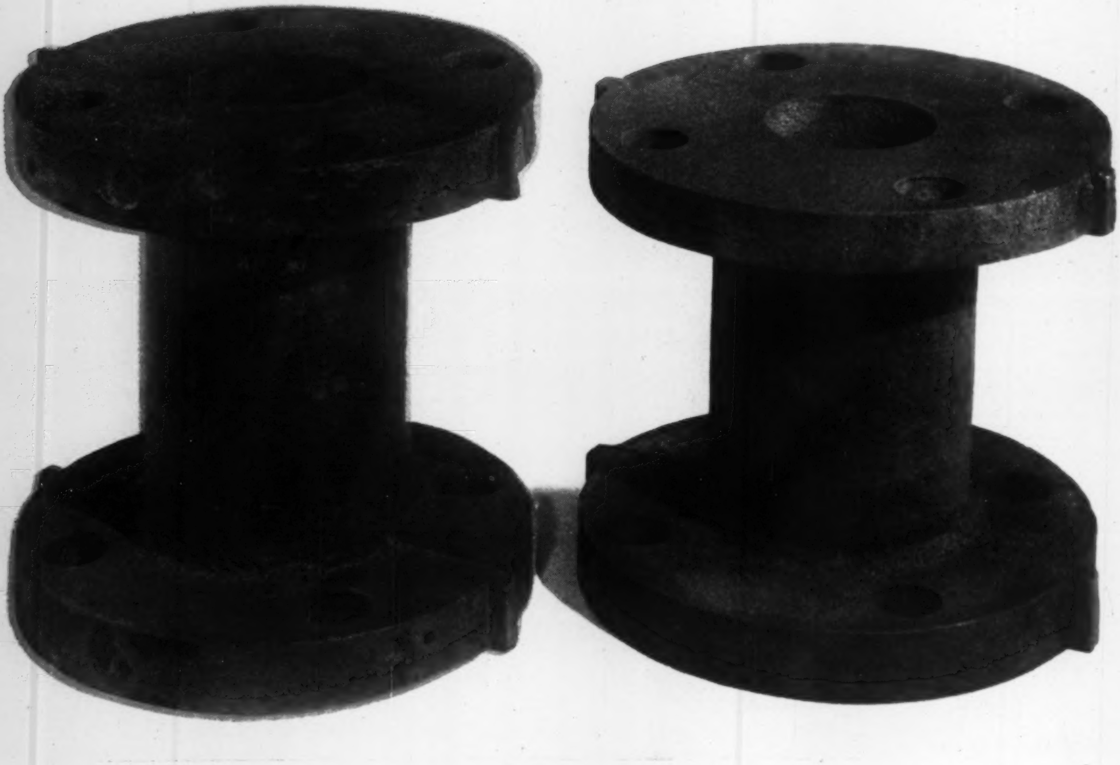
Protected with Solvay Sodium Nitrite!



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SOLVAY SODIUM NITRITE

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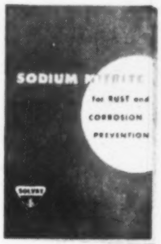
For full facts about this low-cost, proven way to prevent corrosion of ferrous metal and a free test sample, mail the coupon.



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Please send—without obligation:

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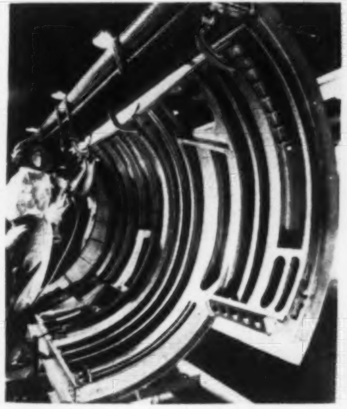
Six Commercial Uses of Titanium

Greater supply and lower prices have helped spread the use of this "defense metal" to commercial applications needing its strength, lightness and corrosion resistance.

Titanium Metals Corp. of America



Access panel *of lightweight titanium is used in Douglas DC-8 engine pods for inspection and servicing. Each Ti-75A panel (102 in. by 76 in.) weighs 80 lb. The 1000 lb used throughout the DC-8 saves weight worth $525 for each coast-to-coast flight, United Airlines estimates.*

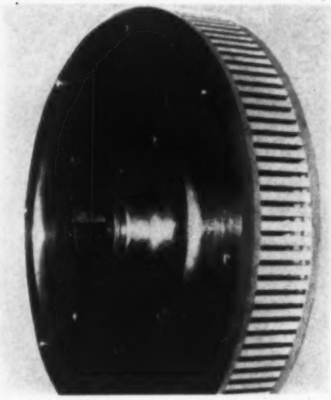
Titanium Metals Corp. of America

Rip stoppers *are high strength Ti-6Al-4V bands riveted at 18-in. intervals around the forward section of the DC-8 fuselage to guard against crack propagation and thus prevent sudden depressurization during flight.*

Pfaudler Co.

Experimental pump impellers *used in a pachuca tank for purifying a highly corrosive liquid (unspecified). The titanium pump (24 in. long with a 14-in. dia impeller) replaces a massive stainless steel unit. Both the cast and welded impellers shown proved satisfactory.*

Columbia Southern Chemical Corp.



Spray wheel dryer, *turning at 10,000 rpm, centrifugally atomizes a calcium hypochlorite solution for drying. Components are machined from RS-130 and A-55 titanium alloys by essentially the same methods used to make the previous Hastelloy dryers. Corrosion has been greatly reduced and excessive bearing wear virtually eliminated.*

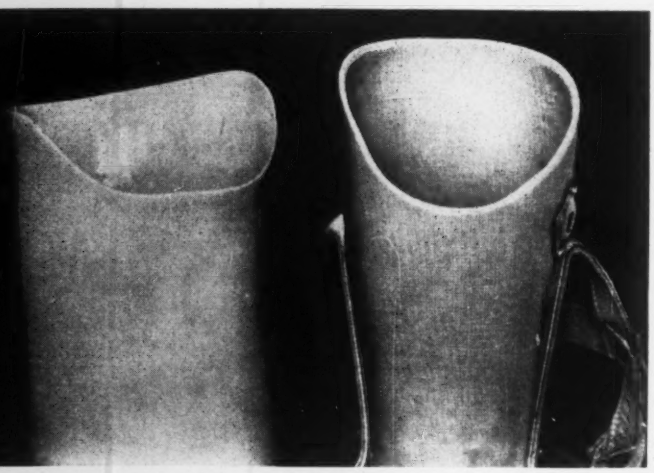
Crane Co.

Y valve *controls highly corrosive, hot slurries of nickel, cobalt and sulfuric acid. This 5-in. valve is forged of commercially pure titanium with ceramic seats and disks and is designed for 600 psi and 475 F. It is part of 28,000 lb of titanium equipment used in the nickel extraction plant built by Freeport Nickel Co. at Moa Bay, Cuba.*

Crane Co.

Titanium tubing *being bent at Crane Co.'s pipe shop before use in the Moa Bay installation. This 8-in. size is said to be the first fabrication of titanium pipe larger than 2 in. Republic Steel Corp. supplied the titanium used in the Moa Bay plant.*

Dacron Reinforcement Makes Stronger,



Finished leg mold *at left is made with polyester reinforcement and has a clear, natural appearance. Old design at right, made with nylon stockinette reinforcement, has unattractive ribbed effect and is less comfortable. The pictures below show how the new mold is made.*

■ For the past two years the Veterans Administration's Prosthetics Center in New York City has been having great success with a nonwoven Dacron polyester fiber blanket reinforcement for its plastics prosthetic devices. In addition to providing greater strength than previous materials, the blanket (Troy Blanket Mills' Troytuf) makes the devices easier to prepare or modify, and better fitting.

In artificial limbs the socket area is the most critical section because it comes in contact with the skin. Prior to using the polyester material, designers and technicans were having difficulties with laminate fillers—sometimes in their preparation, but more often in making changes in the devices and in restoring original finish. Previously used reinforcements such as wood flour, cellulose fiber dipped in acetone, and a variety of acrylics lacked good structural strength. This weakness in some cases led to crazing and cracking. Also, one nylon stockinette filler that was used as an inner liner had ribbed edges which protruded and could not be completely removed. Since the edges were usually in the socket area and in contact with the skin, they often pro-

HOW A BELOW-THE-KNEE LEG MOLD IS MADE

1 Dacron blanket reinforcement is trimmed to size. *After cutting, the nonwoven polyester fiber material is stitched to form a sleeve.*

2 Sleeve is placed over leg mold. *Pliability of polyester blanket allows it to conform to every contour. Bottom of tightly-drawn blanket is later bound with string to prevent material from springing back.*

3 Plastic film is sealed over mold *to act as receptacle and outer mold for liquid resin. Film material is polyvinyl alcohol.*

Better Fitting Prosthetic Devices

duced objectionable irritation.

After considerable experimentation the Center found that a polyester fiber blanket reinforcement used in conjunction with a polyester resin provides superior strength and does not crack or craze. In addition, the material can easily be modified to a new shape and sanded or smoothed to its original finish. Unlike nylon stockinette, no rough edges protrude after changes are made in the device.

Previously, when modifications had to be made in a device the filler had to be smeared on the area to be built up. This operation was complex and messy. Polyester materials, however, lend themselves readily to patching procedures. After roughing the surface of the area to be changed, a piece of polyester blanket is dipped in the laminate resin and applied to the area. It adheres immediately.

4 Liquid resin is poured into mold *to start the lamination process.*

5 Resin is squeezed down over polyester blanket *until it is completely saturated. If resin were allowed to spread at its own speed it would set before lamination was completed.*

6 Stringing the resin *helps distribute it evenly and removes air pockets. When using an air-curing resin this is the last production step before removing device from mold. Otherwise, an oven curing step is required.*

METAL COST CUT MORE THAN 65%...

. . . with miller

200-PLUS

PHOSPHOR BRONZE

The wafer-thin part shown here is a spring contact blade that forms an integral part of an automatic starting and reversing switch used on all models of garbage disposers produced by In-Sink-Erator Manufacturing Company of Racine, Wisconsin. Continued exploration of ways to cut the cost of manufacture—hence deliver a better product for less money—led In-Sink-Erator's design people to Miller, whose on-the-spot metallurgical specialists were able to recommend Grade C 200-PLUS phosphor bronze, a material with equal performance to the beryllium copper previously used . . . yet at far less cost. If cost-cutting has a place in *your* operation, a Miller specialist can be at your plant in hours to tell you how!

ROLLING MILL DIVISION
THE MILLER COMPANY
MERIDEN, CONN.

. . . WHERE PHOSPHOR BRONZE IS THE MAIN LINE—NOT A SIDELINE

For more information, turn to Reader Service card, circle No. 403

New Ceramic Gyro Has Best Accuracy

Use of ceramics has made possible what is described as "the greatest improvement in production gyroscopes in a decade."

The new gyro, which is said to represent a ten-fold improvement in gyro accuracy, was made possible by the development of 1) a new ceramic material as hard as sapphire that can be diamond-honed into the tiny and ultra precise shapes required for critical gyro parts; and 2) a miniature ceramic self-generating gas bearing.

Causes of drift reduced

According to Minneapolis-Honeywell Regulator Co., the combination of ceramic parts and gas bearings has sharply reduced the major causes of gyro drift and inaccuracies, and has resulted in a gyro with a theoretical life span approaching infinity. Thus far, Minneapolis-Honeywell is unwilling to release details on the nature of the new ceramic.

Up to now, gyros have used ball bearings that are relatively unstable and subject to wear. The ceramic bearings in the new gyro are lubricated by a film of gas only 0.0000025 in. thick. The film is virtually friction-free and reduces vibration by a ratio of 30 to 1.

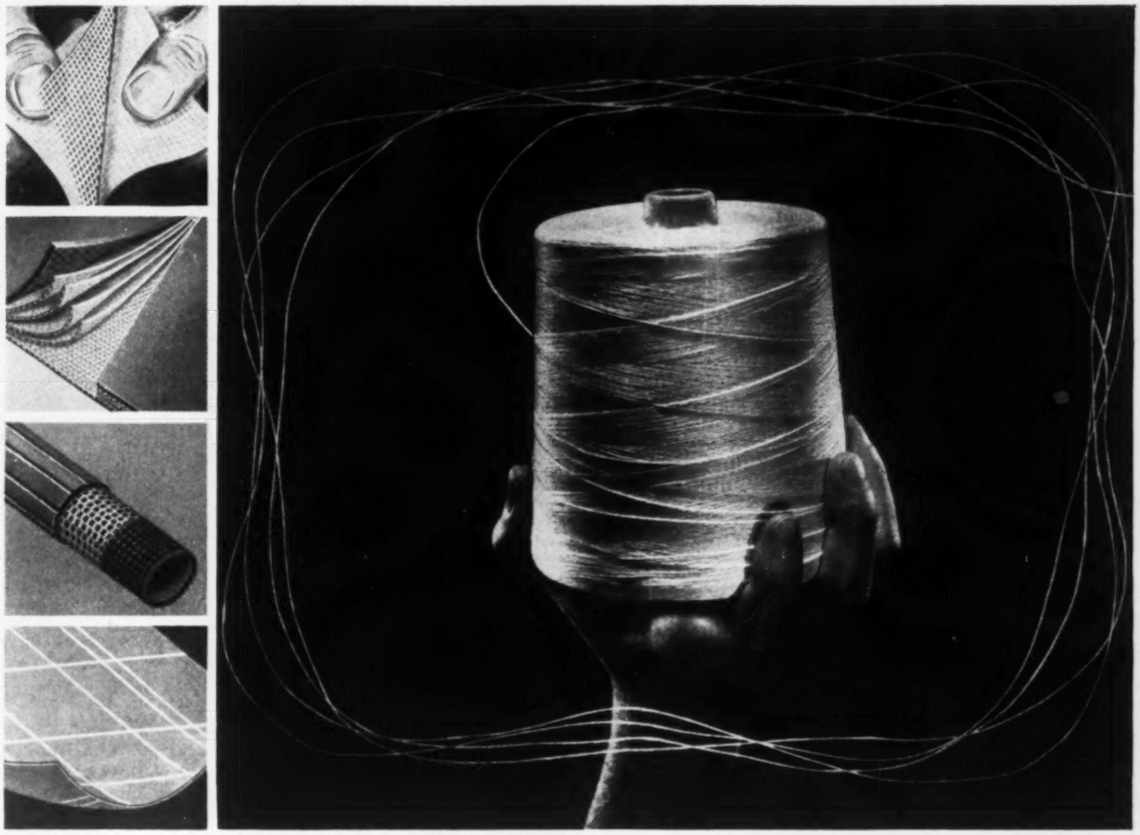
Although the principle of gas bearings is not new, previous models without ceramics have been severely limited in size due to bearing wear caused by frequent stopping and starting. The new gyro, only 2.817 in. long and 2.0 in. in dia, weighs only ½ lb and has thus far successfully withstood many thousands of starts and stops without detectable wear.

In addition to eliminating nearly all drift caused by worn ball bearings, the new gyro also uses ceramics to reduce drift caused by instability of other parts, such as the spin motor and gimbal constructions. In stability tests, the new ceramic parts were found to retain original dimensions within 0.000002 in. after being subjected to temperature variations ranging from −85 F to 1500 F.

Ceramic as hard as sapphire

The gyro parts are rough cast in powdered form. In this half-fired

An example of Avisco Rayons in Industry



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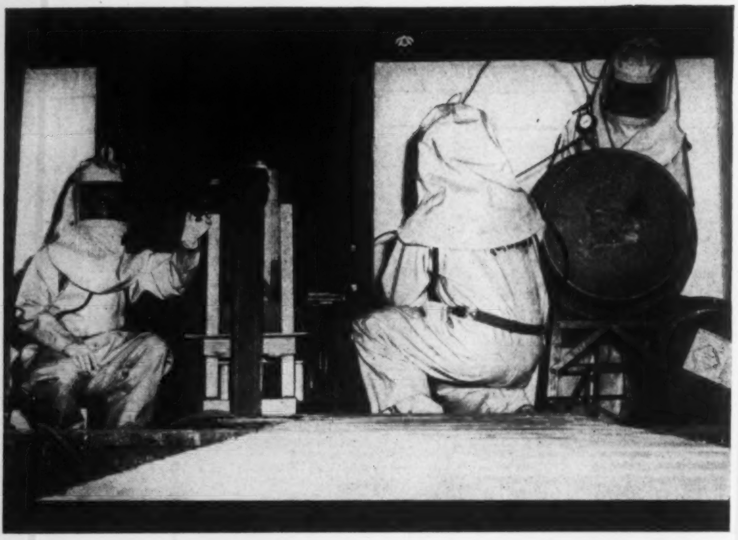

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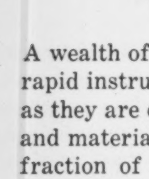

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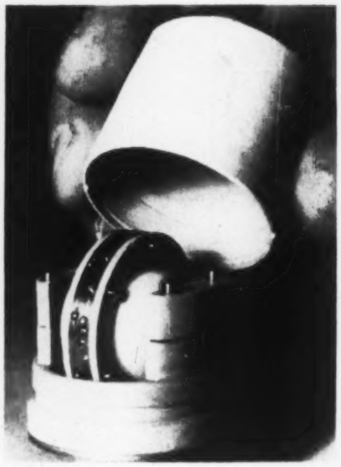
MATERIALS AT WORK

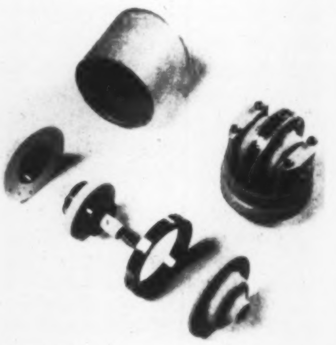


***Tiny precision gyro** about to be encased in its ceramic gimbal.*

"green" state, the material can be easily worked. After final firing at 3200 F, however, the material becomes as hard as sapphire.

Since this hardness is greater than that of ordinary grinding wheel materials, the ceramic parts have to be finish ground with diamond compounds. However, extreme accuracy and excellent surface finish are possible. In fact, Minneapolis-Honeywell says that tolerances on some parts are held to less than ±0.000003 in.

According to Minneapolis-Honey-



Ceramic components *of new gyroscope include: front row, from left to right—gyro end bell, spin motor and shaft, balance wheel (only non-ceramic component) and second end bell; back row—ceramic gimbal and assembled spin motor mounted in a portion of the gimbal.*

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well, the new ceramic gyros, which are designed for use in missile and space vehicle guidance systems, are virtually impervious to the acceleration, vibration, pressure and temperature changes encountered in these applications.

'Impossible' Part Made by Combination Casting

By combining investment and plaster mold casting techniques, Atlantic Casting & Engineering Corp. has been able to produce a precision, one-piece component that previously was impossible to produce in one piece and required costly fabrication and machining operations.

Two parts used previously

The component, a one-piece cross-guide coupler (see accompanying photo), was previously made from two individual H-plane bends that required 1) machining of coupling slots in the wall of one bend, 2) cutting away a wall section of the other bend, and 3) joining both by brazing.

In addition to the time required for these operations, there were these other disadvantages: the brazed joint caused interior irregularities which often could not be reached for smoothing; and an imperfect relationship sometimes existed between the two wave guides.

Part is now a single casting

The new coupler is cast in one piece, complete with coupling slots, by means of a single one-piece core. The core, a rectangular translucent wax section (shown at right of photo) containing two cross-shaped holes, is positioned in the coring mold so that the cross-shaped holes connect the two major elements that form cores for the two H-plane bend interiors. Core slurry flows through these openings in such a way that after the slurry sets and the coring is removed, the form of the entire coupling is reproduced in a single piece. The wax section is then vaporized and the molten metal poured.

According to Atlantic, this method produces a perfectly regular, jointless interior. Cost per part is less because machining, jigging and brazing are eliminated. And performance

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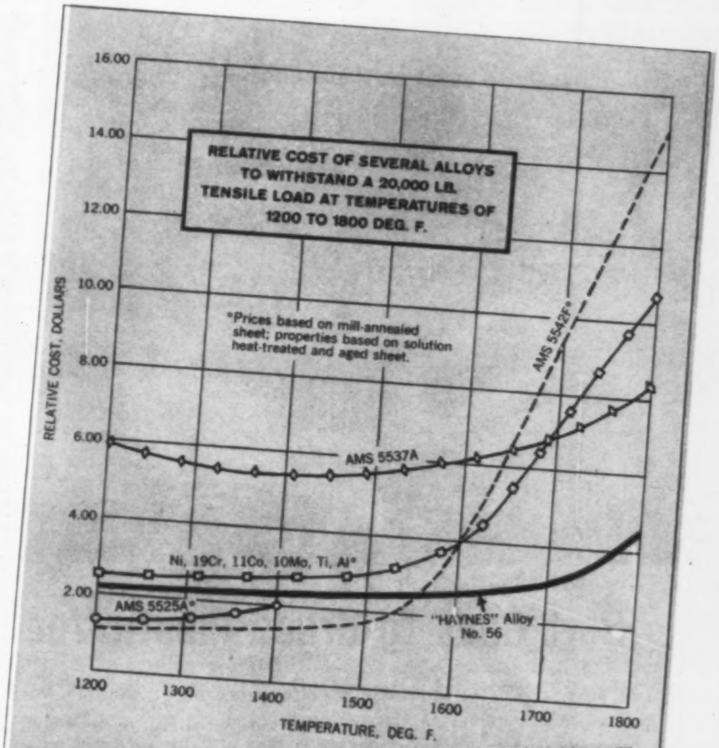
RESEARCH REPORTS

New High-Temperature Alloy Improves Cost-To-Strength Ratio

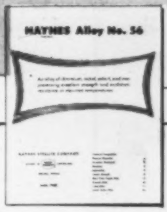


Excellent strength and oxidation resistance in the 1200 to 2000 deg. F. range are among the features of Haynes Alloy No. 56—a new high-temperature alloy developed by Haynes Stellite Company.

A sampling of its cost advantages at a given tensile load, compared with other high-temperature alloys in the graph at the right, is well worth your study.

Alloy No. 56 can be readily hot-worked and formed. It is easy to heat treat. It comes in the form of sheet, plate, bar, wire, and coated welding electrodes, and can be furnished as sand-, investment-, and resin shell-mold castings. The coupon below will bring you a wealth of technical data.

The new iron-base alloy contains nickel, cobalt, chromium, and molybdenum. It has high strength at temperatures up to 1500 deg. F and maintains useful strength at temperatures as high as 2000 deg. F.



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Part Goes to Grace Plastic for Greater Durability

Automatic Milk Service, Inc. improved the performance of its coin operated milk vending machines through a change in design and material for one key part. The part is a chute through which milk cartons are dispensed. Produced the new way, it rarely requires repairs or maintenance.

The chute is subjected to rugged treatment every time the machine is operated (a carton of milk is released from above and hits the chute with considerable impact), and every time the machine is filled (the serviceman uses the chute as a platform to hold his milk case). Many different materials were tested for the part. Grace's high density polyethylene was chosen as the material that could withstand such abuse over a long period. The chute was redesigned for efficient vacuum forming with Grex sheet by Highland Products, Inc.

Chutes made from this Grace plastic stand up so well they rarely require attention. Even in cold weather, when other plastic materials lose their strength, these Grex chutes will not crack or break on impact.

For the vending machine company the use of Grex means longer chute life and lower maintenance costs. Perhaps you can reduce costs, too, by taking advantage of Grex for your products. The best way to find out is by calling in the experts. Grace has the production, technical and marketing facilities to help put your product in the Grex profit parade. Everyone says we're easy to do business with.

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GRACE
TECHNICAL
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Large part designed with deep draws successfully vacuum formed from Grex sheet.

The experience of Highland Products, Inc. in redesigning and forming the chute for milk dispensing machines may give you some ideas on how to take maximum advantage of Grex for your *own* projects.

Simplification in design was the first step in production of the part. Originally it was a complicated assembly of nearly twenty pieces. The new design by Highland calls for only two large vacuum formed Grex pieces plus three flat Grex strips as stiffening members.

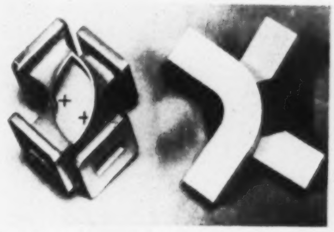
Deep draw required. In the interests of production efficiency and part performance, Highland's design calls for deep draws, straight walls and sharp corners. Such design requirements are difficult to satisfy in thermoforming many types of plastic sheet. The fact that satisfactory parts are being produced may be attributed to the thermoforming characteristics of high density polyethylene.

Slow cooling an advantage. High density polyethylene remains workable for a relatively long period. In this case, the Grex sheet is workable for 60 to 90 seconds after drawdown—sufficient time to obtain necessary detail on the sides of the pieces.

Want to know more about what can be accomplished by vacuum forming of Grex sheet? If you have an application in mind, give Grace Technical Service the opportunity to help you. We may not know all the answers, but we do have experience with high density polyethylene on our side—and are learning more every day.

Technical Service Department
W. R. Grace & Co., Clifton, New Jersey

MATERIALS AT WORK



***Intricate coupling** (left) is cast in one piece using wax pattern (right).*

of the finished part is superior because the two channels are positioned with greater accuracy.

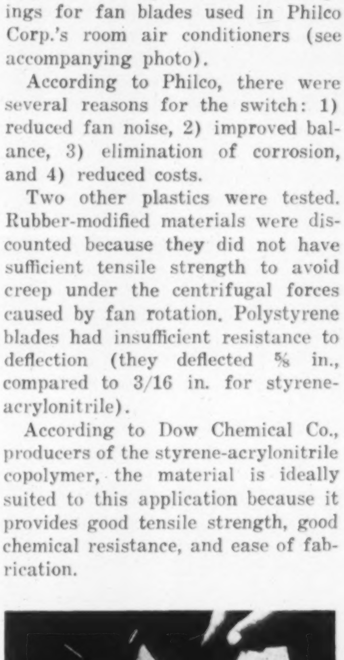
Styrene-Acrylonitrile Replaces Metal Blade

Molded styrene-acrylonitrile copolymer has replaced metal stampings for fan blades used in Philco Corp.'s room air conditioners (see accompanying photo).

According to Philco, there were several reasons for the switch: 1) reduced fan noise, 2) improved balance, 3) elimination of corrosion, and 4) reduced costs.

Two other plastics were tested. Rubber-modified materials were discounted because they did not have sufficient tensile strength to avoid creep under the centrifugal forces caused by fan rotation. Polystyrene blades had insufficient resistance to deflection (they deflected ⅝ in., compared to 3/16 in. for styrene-acrylonitrile).

According to Dow Chemical Co., producers of the styrene-acrylonitrile copolymer, the material is ideally suited to this application because it provides good tensile strength, good chemical resistance, and ease of fabrication.



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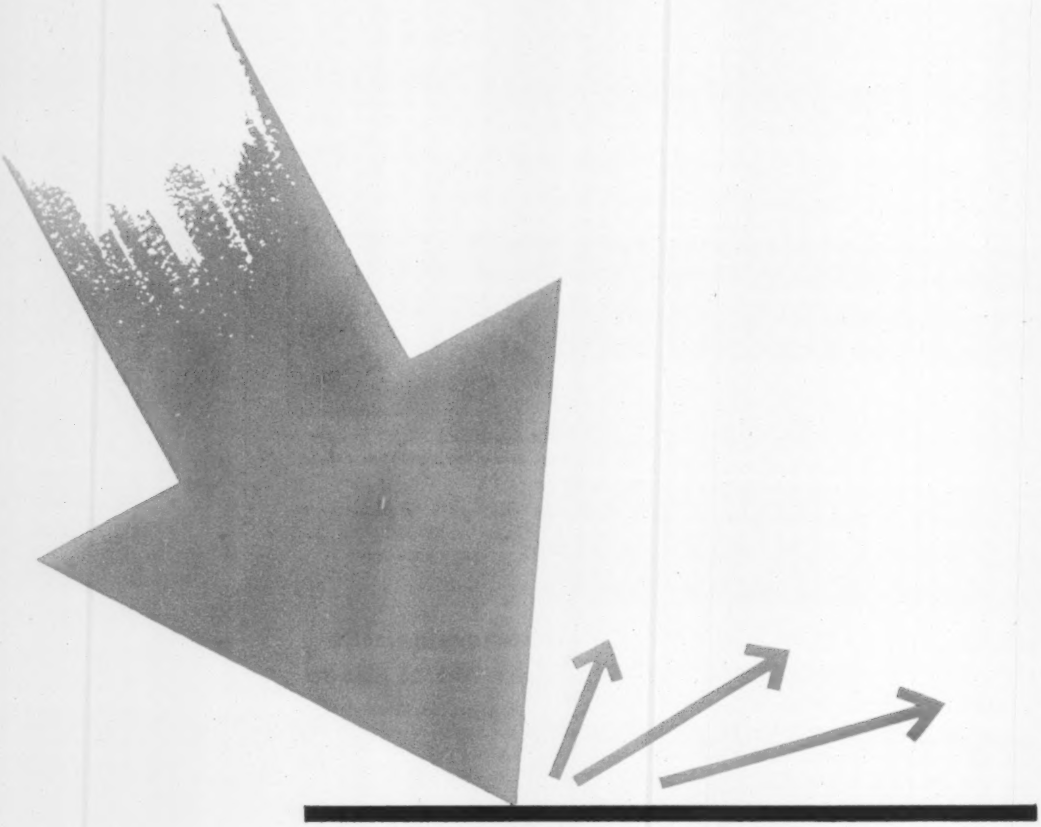

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(cont'd from p 122)

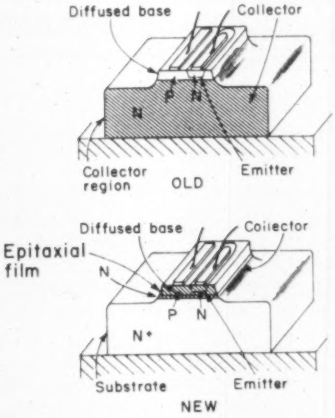
Film Technique for Transistors

Major reductions in switching times and collector resistances of silicon and germanium-base transistors have been realized at Bell Telephone Laboratories by using epitaxially grown films, i.e., films grown as an extension of a single crystal substrate.

According to the developer, diffused base transistors require a relatively high resistivity collector region in order to attain low capacitance and high voltage breakdown. To date, the collector region has been much thicker than required electrically in order to afford ease in handling. However, the excess thickness increases collector resistance and, through carrier storage, switching time.

Thickness of collector region reduced by new technique

Ideally, the thickness of the collector region should be 0.1 mil. Semiconductor wafers prepared by conventional methods become extremely difficult, if not impossible, to handle as they approach this desired thinness.



***Thickness** of collector region in a conventional diffused base transistor (top) has been reduced considerably in new epitaxial diffused transistor construction (bottom).*

But Bell Telephone Laboratories says the problem of a thinner collector region can be solved by using epitaxial film techniques. Lightly doped epitaxial films are grown on and supported by a low resistivity substrate giving the desired combination of electrical properties and mechanical strength.

Tests show that switching time in a typical silicon transistor circuit has been reduced from 200 to 20 millimicroseconds by using the epitaxial film technique. In addition, collector series resistance of the epitaxial transistors was reduced by a factor of more than 10 and was comparable to that of conventional devices 15 times larger.

Bell Telephone Laboratories, located at 463 West St., New York 14, says use of epitaxial material in diffused base transistors simplifies the design and understanding of transistor devices and brings them closer to ideal forms.

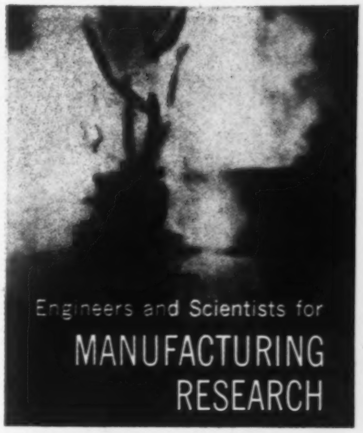
Hydrogen Blamed for Rusting of Iron

What causes iron to rust?

Dr. Earl A. Gulbransen and T. P. Copan, scientists at Westinghouse Research Laboratories in Pittsburgh, suggest that tiny hydrogen particles from water vapors penetrate iron and enlarge the sites at which oxygen normally combines with the metal. This spreads the reaction throughout the surface of the iron, causing it to rust destructively.

Theory may supplant standard explanation for iron corrosion

Until now, a standard explanation for iron corrosion has been that it is an electrochemical reaction, i.e., tiny local areas on the surface of the metal are assumed to act as plus and minus electrical terminals under the influence of an invisible liquid film of water, generating minute electrical currents that corrode



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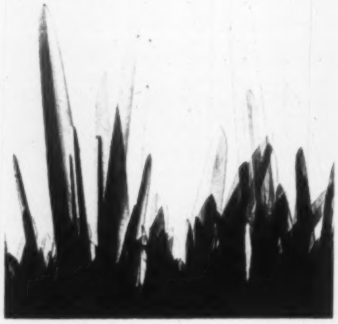

***Destructive crystals** of iron oxide erupt on the surface of iron when the metal is exposed to an atmosphere of water vapor.*

the iron. The new theory suggests that something more fundamental takes place in iron, even though an electrochemical reaction may also be present.

Complex rusting of iron reduced to simple process

Gulbransen and Copan arrived at their finding by conducting a series of experiments in which the complex rusting of iron was reduced to its simplest atomic processes, i.e., conditions required for electrochemical reactions were eliminated in the experiments.

They took pure iron wires about as thick as a fine sewing thread and reacted them with oxygen and water vapor at 835 F under closely controlled conditions. The iron wires were then studied under an electron microscope capable of magnifying objects up to 300,000 times. Here's what the microscope showed:

1. In a dry oxygen atmosphere the iron forms a protective oxide coating from which grow billions of tiny oxide whiskers less than one millionth of an inch in diameter and 30 millionths of an inch high. Each whisker grows from a single, specific growth site on the metal's surface.

2. But in an atmosphere of water vapor the surface of the iron erupts into thin, blade-shaped platelets of iron oxide (see accompanying photo), which reach a density of nearly one billion per square inch of surface area. As the blades grow in size,

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Nickel Base	1800° F	U CHROMALLIZED nickel base alloys are unattacked after 200 hours at 2000° F.
Cobalt Base	1800° F	SAC CHROMALLIZED cobalt base alloys are unattacked after 150 hours at 2200° F.
Molybdenum	Over 2000° F	W-2 CHROMALLIZED molybdenum shows no failure after 400 hours at 2350° F, after 48 minutes at 2800° F, and after one minute at 3400° F.

Ordinary steel can also be chromallized to provide resistance to corrosion, oxidation and wear.

A recent Chromalloy development, IOCHROME (99.997 % pure chromium), is a basis for chromium alloys for use at 2500°F.

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they spread across the surface of the iron, causing it to corrode destructively.

The platelets are about one millionth of an inch thick, 30 millionths of an inch wide and 300 millionths of an inch high. The amount of rust the platelets represent is 250 times that which forms when the water vapor, and the hydrogen ions it releases, are absent from the reaction.

Small amount of water vapor starts rusting of iron

The experiments show that less than one part of water vapor in 200 parts of the dry oxygen atmosphere will cause the blade-shaped crystals to form. This corresponds to a relative humidity of about 3% at room temperature.

In order to reduce iron corrosion, estimated to waste some $6 to $7 billion per year in this country, Gulbransen says, "Hydrogen must be prevented from entering the metal, and the growth of the localized reaction sites must be inhibited by the addition of suitable alloying elements to the iron."

Stainless studied earlier

In an earlier work on stress-corrosion cracking of stainless steel (see M/DE, Jan '58, p 150), Gulbransen found that minute crystals, described as submicroscopic platelets of chromium oxide, tend to grow from the surface of stainless steels when the metals are stressed and exposed to corroding atmospheres.

New Property Data on Heat Resistant Epoxy

The accompanying table (p 166) gives more property data on a new high temperature epoxy resin called VC-8359. The data were obtained from qualification tests performed by the Forest Products Laboratory as specified under military specification MIL-R-9300A.

The epoxy resin, developed by Brunswick Corp. (formerly Brunswick-Balke-Collender Co.), Marion, Va., was described in the April issue of this magazine (p 17). A B-staged prepreg containing VC-8359 and either glass cloth or roving is commercially available from

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PROPERTIES OF VC-8359 LAMINATES[a]

	MIL-R-9300-A Requirements	VC-8359
ORIGINAL MECHANICAL PROPERTIES		
Flex Str, 1000 psi	70	**76**
Flex Mod of Elast, 10^6 psi	3.2	**3.47**
Ult Ten Str, 1000 psi	47	**59**
Ult Compr Str (edgewise), 1000 psi	50	**62**
AFTER AGING IN WATER[b]		
Flex Str, 1000 psi	65	**72**
Flex Mod of Elast, 10^6 psi	3.2	**3.40**
Ult Ten Str, 1000 psi	45	**58**
Ult Compr Str (edgewise), 1000 psi	45	**51**
AFTER OUTDOOR WEATHERING[c]		
Flex Str, 1000 psi	65	**76**
Flex Mod of Elast, 10^6 psi	3.2	**3.66**
AFTER AGING IN MIL-O-5606 OIL[d]		
Ult Flex Str, 1000 psi	65	**77**
Weight Chg, %	±2.0 max	**+0.04**
Thickness Chg, %	±0.2 max	**+0.05**
AFTER AGING IN MIL-F-5566 FLUID[d]		
Ult Flex Str, 1000 psi	65	**80**
Weight Chg, %	±2.0 max	**−0.07**
Thickness Chg, %	±0.1 max	**−0.05**
AFTER AGING IN MIL-H-3136 FLUID[d]		
Ult Flex Str, 1000 psi	65	**76**
Weight Chg, %	±2.0 max	**−0.01**
Thickness Chg, %	±0.2 max	**−0.05**

[a] Specimens: 12-ply, ⅛ in. thick, 181 cloth, Volan A finish, 33% resin. Test methods as specified in Fed Spec LP-406-b.
[b] Aged 30 days at room temperature, then tested wet.
[c] Aged three months.
[d] Specimens aged 7 days at room temperature in accordance with Fed Spec LP-406-b, Method 7011.

U. S. Polymeric Chemicals, Inc., 700 Dyer Rd., Santa Ana, Calif.

Preparation of laminates

As reported in the April issue, wettability and viscosity of the new epoxy resin are such that several plies of cloth can be laid down and impregnated at once, as opposed to the standard procedure of impreg-

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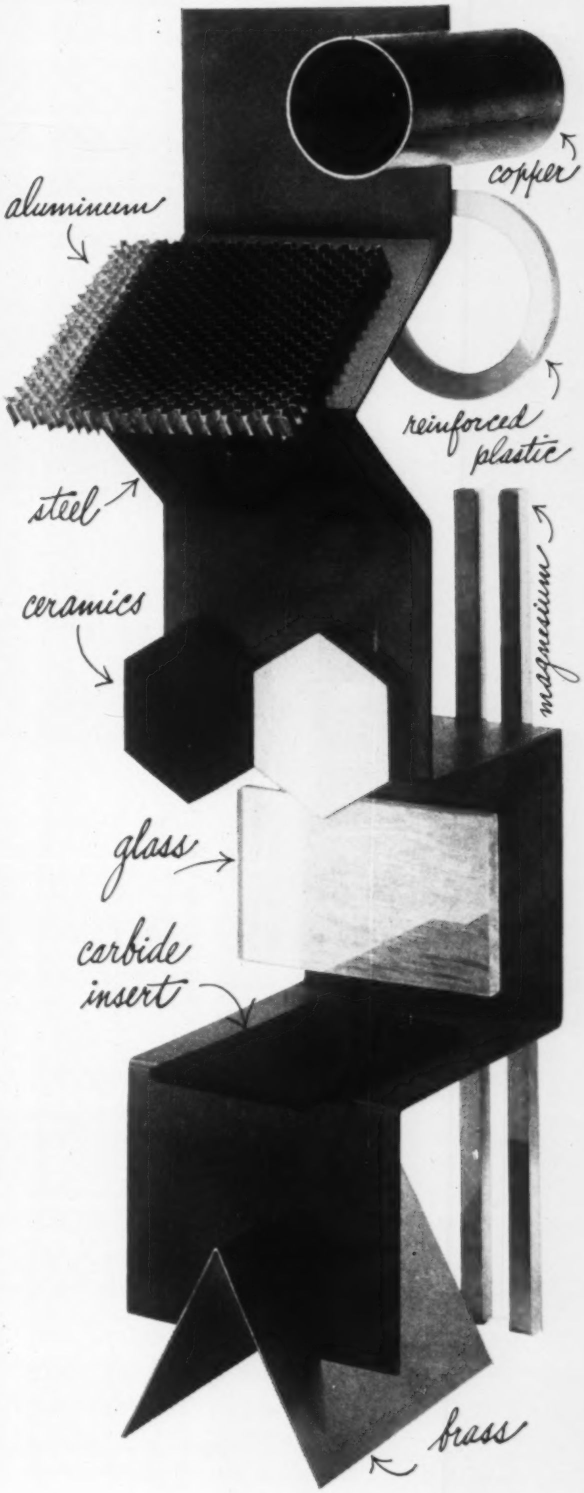

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Westinghouse investment casting produced this circuit breaker trigger as a single piece. Elimination of machining and assembly time reduced production costs by 60%.

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nating one ply at a time.

The developer recommends the following procedure for preparing and curing VC-8359 laminates:

1. Weight of catalyzed resin should equal weight of the cloth, and the cloth should be 181 style with Volan-A finish. Layup should be parallel to the warp.

2. After layup, the laminate should be bagged and placed in an oven at 250 F. Flat laminates should be prepared on a polyester film that has been taped to an aluminum platen.

3. After heating for 20 min, the laminate should be removed from the oven, squeezed to the correct thickness, and returned for 3 hr at 250 F. Polyester film and bag material should be removed from the laminate immediately after it is removed from the oven.

Mechanical Properties of Spun Metal Parts

In spite of the relatively wide use of spinning as a forming method there is little information available on the mechanical properties of spun metal parts. But a recent report on the mechanical properties of spun metal parts by four University of Michigan investigators should help fill in some of the gaps.

The investigators performed a series of tensile tests on mechanically and hand spun cartridge brass (70% copper–30% zinc) and aluminum alloy 1100.

Spinning analogous to cold rolling

Data from their tests showed that tensile and yield strengths of mechanically and hand spun parts increased, and elongation decreased, with increasing reductions in thickness.

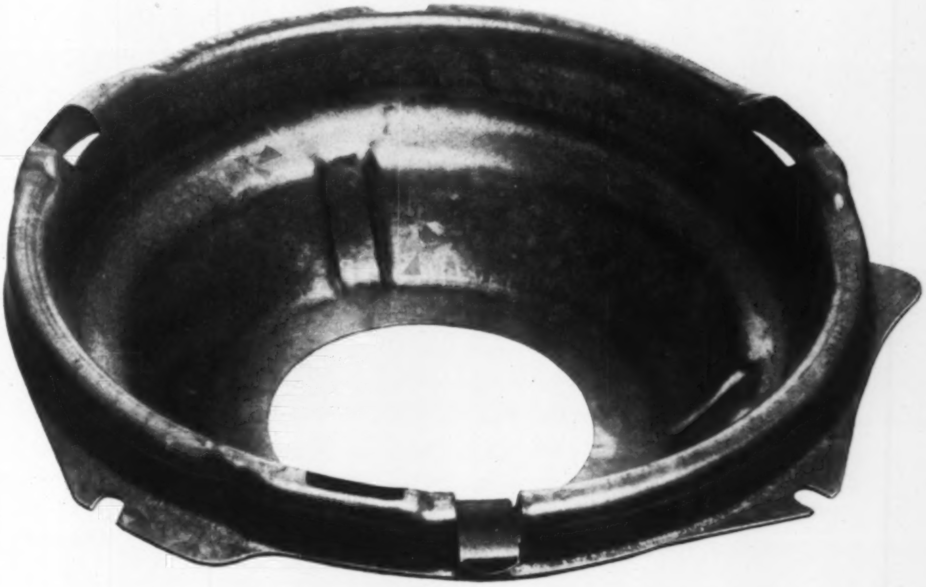
Other data derived from the tests showed the following:

1. Tensile properties of mechanically spun parts are similar to properties produced by cold rolling to an equivalent reduction. Thus, tensile properties of mechanically spun parts can be estimated from

---

Based on a paper written by S. Floreen, D. V. Ragone, E. E. Hucke and W. D. Carleton of the University of Michigan Research Inst., Ann Arbor, Mich.

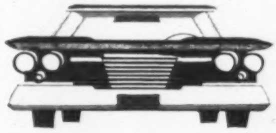
Better products through better methods and steels



How zinc-coated steel cut 5 steps from automotive lamp housing fabrication.

When automotive head and tail lamp housings were drawn from cold rolled sheet steel and then zinc-plated or painted, as many as five or six handling and cleaning steps were required to make them corrosion-resistant.

Now, fabricated from Weirkote continuous-process zinc-coated steel, the housings go directly from the press to the assembly line. Further processing is unnecessary because Weirkote can be worked to the limits of the steel itself without chipping or flaking its corrosion-resistant zinc surface.



It's this superiority that caused the automobile industry to increase its consumption of zinc-coated steel more than 700% in five years; to use it in such varied applications as mufflers, window channels and the understructures of unitized bodies; to take advantage of developments such as differentially zinc-coated steel that can be welded at top production-line speeds.

A major supplier is Weirton Steel Company—producer of Weirkote continuous-process zinc-coated steel sheets and many other excellent steels that are improving products, methods and profits throughout industry.

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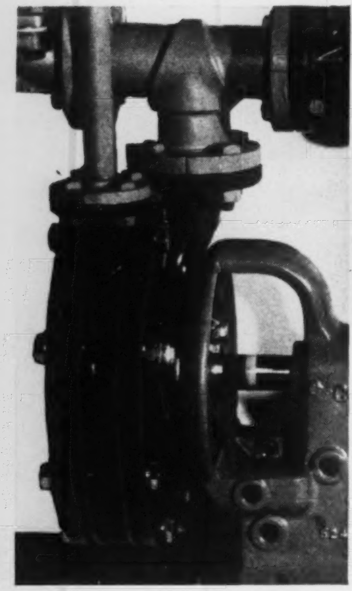
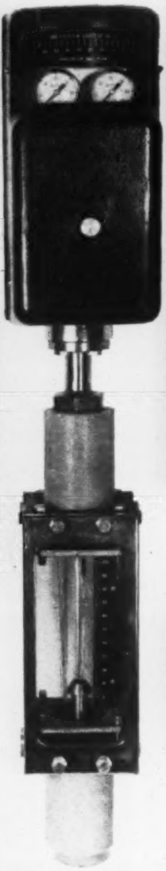
Weirkote will also be available in 1961 from National's Midwest Steel Division, Portage, Indiana.





Protect your processing equipment from corrosion with CORVEL®-Penton† Coatings

▲ This pump has a 25 mil Penton coating applied by fluidized bed process to pump impeller and both the inside and outside of pump head, providing internal protection against corrosive fluids as well as an exterior surface finish resistant to corrosive atmosphere.

(PHOTO COURTESY GOULDS PUMPS, INC.)

Flowmeter coated with CORVEL-Penton provides high-order corrosion resistance for use in a wide variety of chemical atmospheres that attack metals. ▶

(PHOTO COURTESY BROOKS ROTAMETER CO.)

Iron pipe and flanges coated with CORVEL-Penton on internal and external surfaces.

WHIRLCLAD® Custom Coating Service

CORVEL-Penton provides ideal, high order corrosion protection for valves, pumps, flow meters, pipe and fittings in the chemical, food and other processing industries. Because of their excellent resistance to almost all acids, alkalis, solvents and chlorides, CORVEL-Penton coatings on low cost metals are unmatched in performance and economy . . . competitive in cost with low order corrosion protection.

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In Polymer's WHIRLCLAD custom coating service, Penton is applied to valves, pipes and processing equipment in the WHIRLCLAD coating system‡, utilizing a fluidized bed of dry, finely divided resin powders. The powders heat-fuse to form a uniform, continuous film with thorough coverage of edges, corners and projections on complex shapes. Pin-hole-free coatings are readily obtained in thicknesses of .010" and over. Coatings of vinyl, polyethylene, cellulosic, nylon and epoxy are also available.

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- **Experienced engineering assistance**

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‡The basic fluidized bed process was developed and patented in Germany. Polymer's WHIRLCLAD coating system which encompasses the fluidized bed technique is protected by various apparatus and process patents in the United States and foreign countries and numerous applications are pending. Exclusive patents and licensing rights in the United States and Canada are owned by a subsidiary of The Polymer Corporation.

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Reading, Pennsylvania

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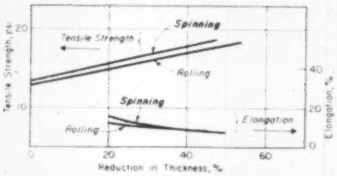

Properties of aluminum: *mechanical spinning vs cold rolling.*

cold rolled properties.

2. Tensile properties of mechanically spun parts depend on the relative change in die dimensions and not on the original thickness of the unspun blank.

3. Hand spun parts have a smaller increase in tensile properties than mechanically spun parts. Hand spun parts also have a much greater scatter in tensile values.

4. There is a progressive decrease in hardness from the spun surface to the back surface of mechanically spun parts, as indicated by micro-

PROPERTIES OF SPUN ALUMINUM[a]

Cone Angle, deg ➡	63	85	108
MECHANICALLY SPUN			
Ten Str, 1000 psi	19	18	16
Yld Str (0.2% offset), 1000 psi	17	16	15
Elong (in 1 in.), %	9	10	12
Hardness (Brinell)	30	28	27
HAND SPUN[b]			
Ten Str, 1000 psi	16	17	15
Yld Str (0.2% offset), 1000 psi	14	17	14
Elong (in 1 in.), %	15	16	14
Hardness (Brinell)	29	28	27

[a] Values given for radial test specimens spun from an 0.081-in. thick blank.
[b] Values give are an average of four test specimens.

PROPERTIES OF SPUN BRASS[a]

Cone Angle, deg ➡	63	85	108
MECHANICALLY SPUN			
Ten Str, 1000 psi	80	78	70
Yld Str (0.2% offset), 1000 psi	75	63	66
Elong (in 1 in.), %	7	10	9
Hardness (Rockwell)	B87	B85	B80
HAND SPUN[b]			
Ten Str, 1000 psi	72	70	63
Yld Str (0.2% offset), 1000 psi	57	66	59
Elong (in 1 in.), %	8	14	15
Hardness (Rockwell)	76	72	69

[a] Values given for radial test specimens.
[b] Values given are an average of four test specimens.

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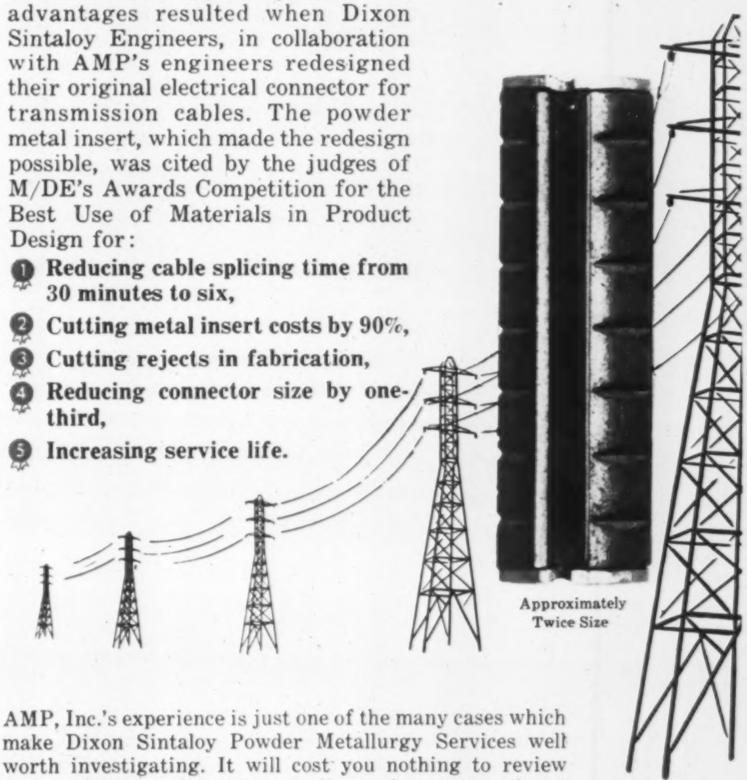
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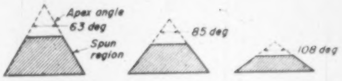

Schematic view *showing various cone angles of spun metal parts.*

hardness measurements. However, hardness of mechanically spun parts is generally higher than that of hand spun parts.

5. Mechanical spinning is the best method to use if overall uniformity of strength is desired in a spun part.

6. There is a relatively constant hardness through the cross section of hand spun parts. Accordingly, hand spinning would seem to be the best method to use if a spun part were to be age hardened.

Testing, spinning procedures

The tensile specimens used in the tests were taken in radial and tangential directions from spun cones. No differences in tensile properties were observed in the two directions.

Different reductions were obtained by varying the apex angles of the cones. The angles were 63, 85 and 108 deg. In all cases the final diameters of the cones were approximately constant and equal to the original diameter of the unspun blank.

Vanadium Resists Salt Water, Acids

Chemical and galvanic corrosion studies by D. Schlain, C. B. Kenahan and W. L. Acherman of the Dept. of the Interior, Div. of Mineral Technology, College Park, Md. show that ductile vanadium has good resistance to salt water, 60% sulfuric acid and 20% hydrochloric acid at 95 F.

The tests further show that vanadium, although it has good resistance to 3% nitric acid, corrodes very rapidly in 17% nitric acid. Absence of air had little or no effect on the corrosion of vanadium in these environments.

The three men, whose work is described in the Feb '60 issue of *Corrosion*, say that vanadium is less corrosion resistant in salt water than stainless steel and copper, but is more resistant than aluminum, magnesium and SAE 4130 steel.

They say that vanadium, when

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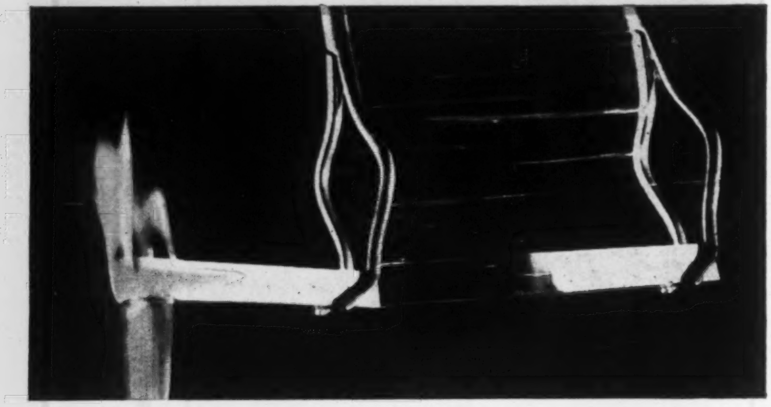
VOLUME 1 NUMBER 2

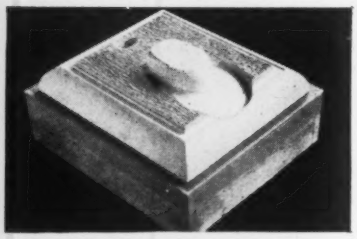
HYSOL HY-LITES

LATEST DEVELOPMENTS IN EPOXY COMPOUNDS



NEW IMMEDIATE FLAME-OUT FLEXIBLE EPOXY CASTING SYSTEM

HYSOL 15-032, a new two-component, flame-retardant epoxy casting system, is available for embedding, encapsulating and insulating electronic/electrical components where flame-resistant characteristics are essential.
Non-burning by ASTM D635-56T standards, and self-extinguishing according to MIL T-27A tests, HYSOL 15-032 is flexible . . . can be used as embedding material when required to meet thermal shock conditions. HYSOL 15-032 flame-retardant qualities are demonstrated in the photo above. 15-032 snuffs out immediately upon removal from Bunsen Burner flame. For complete information write for Bulletin E-215.



Craft Industries, Inc., use POPCORN FILLER IN EPOXY TOOL FOR VACUUM FORMING

As an example of the versatility of HYSOL Epoxy Tooling Materials, Craft Industries, Inc., Buffalo, N. Y. used popcorn and puffed wheat to create a cellular structure filler for this HYSOL Epoxy Tool. The original pattern is unique, too . . . made of wood, paper and plaster. Cast in plaster, details in the design were refined and then a HYSOL Epoxy Tool was made from the plaster. Over 2,000 vacuum-formed parts have been made and the tool is still in use. Long-life, accurate detail, versatility and economy are cited by Craft Industries as their reason for standardizing on HYSOL Epoxy Tooling in all vacuum forming patterns.
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If heat resistance is your bonding problem, here's your solution. HYSOL 4322 now provides Tensile Shear of 2200 PSI @ 300°F on aluminum to aluminum bond. Other advantages are . . . ease of application, non-flow during cure, resistance to thermal shock and a shelf life of 14 months. For complete information write for Bulletin A-304.

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coupled with these metals, behaves as a sacrificial metal for copper, but is protected by aluminum, SAE 4130 steel and magnesium. Neither vanadium nor stainless steel is affected by contact with each other, according to the researchers.

Ceramics Promising for Space Flight Use

A new approach to use of ceramics in space flight in which the material modifies itself to meet environmental conditions was described by D. M. Scruggs of Bendix Aircraft Corp. at a recent meeting of the American Ceramic Society.

Scruggs reported that iron, nickel and chromium oxide coatings on a magnesia base ablate at temperatures as high as 4500 F and at speeds as high as mach 1.8 to produce a thin layer of molten magnesium oxide which protects the magnesia base.

He says this approach can be used to meet certain materials requirements for rockets, atomic reactors, ramjets and other applications.

Welding Method Joins Coated Steel

Magnetic force welding can be used to attach brackets, braces and other parts to steel that has been coated on one side with paint or acrylic lacquer.

It can also be used to fabricate steel that has been laminated on one side with wood veneer, according to Precision Welder and Flexopress Corp., 3518 Ibsen Ave., Cincinnati 9, Ohio.

The technique, described in the Jan '60 issue of this magazine (p 119), is said to produce strong welds that are invisible on the coated side of the metal.

The magnetic force welder used in the technique is usually a conventional spot welder that has been redesigned to accommodate electromagnets for the application of pressure. In most applications, the welding time is short, varying from one-half to a few cycles.

Atmosphere generator tube to resist temperatures of 1800°-2300°F is installed by Lindberg Engineering Company, Chicago. Tube is centrifugally cast from Duraloy "HOM"*, a special high-nickel alloy developed by The Duraloy Company for hot strength in oxidizing atmospheres.

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TECHNICAL LITERATURE

(cont'd from p 43)

Books

Progress in Non-Destructive Testing: Vol. 2. *Edited by E. G. Stanford and J. H. Fearon. Macmillan Co., New York. 1960. Cloth, 6 by 10 in., 257 pp. Price $12.*

Subjects covered in the book are: 1) radiology with high energy x-rays; 2) mechanical testing of high polymers; 3) application of electrical methods for detecting flaws and for studying metal structures; 4) use of radioactive isotopes in nondestructive testing; 5) defect assessment using ultrasonic waves; 6) studies of aging and precipitation in metals using anelastic damping measurements; and 7) application of paramagnetic resonance to nondestructive testing.

The first volume of this annual series of books on nondestructive testing was reviewed in the May '60 issue of M/DE (p 196).

Books on Brass and Bronze.

Cast Bronze Bearing Design Manual. *Prepared by H. C. Rippel. Cast Bronze Bearing Design Inst., Inc., Evanston, Ill. 1960. Cloth, 8¼ by 11¼ in., 72 pp. Price $2*

Contains the latest theoretical and experimental information on bronze bearing design. The various chapters in the book give information on cast bronze sleeve bearings, bearing bronze selection, lubrication, bearing fabrication and assembly, and grooving specifications.

Ingot Brass and Bronze. *Brass and Bronze Ingot Inst., Chicago. 1960. Paper, 8½ by 11 in., 118 pp.*

Discusses nomenclature and classification of brass and bronze alloys, and gives chemical composition, properties, specifications and uses of various brass and bronze casting alloys.

The Dymaxion World of Buckminster Fuller. *R. W. Marks. Reinhold Publishing Corp., New York. 1960. Cloth, 8¼ by 10¼ in., 232 pp. Price $12*

This book, a comprehensive review of Mr. Fuller's work in developing new structural concepts in housing, transportation and industry, is of general interest to many engineers. Of special interest to materials people is Mr. Fuller's imaginative use of new materials, especially lightweight materials for efficient load-bearing structures.

The book is illustrated with over 350 fully captioned photographs and drawings that graphically depict the plans and structures in Fuller's Dymaxion world. The Dymaxion idea is "to get from any type of structure the maximum net performance per unit of energy input."

Non-Crystalline Solids. *Edited by V. D. Frechette. John Wiley & Sons, Inc., New York. 1960. Cloth, 6 by 9 in., 554 pp. Price $15*

Subjects covered include: 1) thermal conductivity of glass; 2) amorphous sulfur and selenium; 3) anomalous properties of vitreous silica; 4) amorphous layers and their physical properties; 5) magnetic resonance studies of glasses; 6) strength of amorph-

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Greases Hydrogen Animal Glues
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Methylene Chloride Oleum Perchlorethylene
Potassium Nitrate Rochelle Salt
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Sodium Sulfate Sulfur Chlorides
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ous solids; 7) electron diffraction techniques for studying amorphous systems; and 8) network defects in noncrystalline solids.

Properties and Structure of Polymers. *A. V. Tobolsky. John Wiley & Sons, Inc., New York. 1960. Cloth, 6 by 9 in., 341 pp. Price $14.50*

Discusses mechanical behavior of polymers (e.g., fibers, rubber, plastics, etc.) in terms of molecular architecture and dynamics. The book shows how important problems in polymer chemistry can be solved by studying the mechanical behavior of polymers.

Photoconductivity of Solids. *R. H. Bube. John Wiley & Sons, Inc., New York. 1960. Cloth, 6 by 9 in., 481 pp. Price $14.75*

Discusses photoconductivity phenomena in various materials. The book contains a comprehensive bibliography of the literature on photoconductivity and a list of photoconducting materials that have been investigated to date.

Basics of Induction Heating: Vol. 1. *C. A. Tudbury. John F. Rider Publisher, Inc., New York. 1960. Paper, 6 by 9 in., 137 pp. Price $3.90*

Explains what induction heating is and how it works. The book also describes the more common types of induction heating equipment in use today.

Surface Effects on Spacecraft Materials. *Edited by F. J. Clauss. John Wiley & Sons, Inc., New York. 1960. Cloth, 8½ by 11 in., 420 pp. Price $11.50*

Discusses coatings for space vehicles, emissivity of materials near room temperature, material sublimation and surface effects in high vacuum, and effects of ultraviolet radiation on organic film-forming polymers. The book also discusses interplanetary dust distribution and erosion effects, atomic and molecular sputtering, surface phenomena and friction, and high temperature emissivity and spectral reflectance measurements.

ASTM Books on Materials. *American Society for Testing Materials, Philadelphia.*

1959 ASTM Proceedings: Vol. 59. *1960. Cloth, 6 by 9 in., 1424 pp. Price $12*

Contains technical papers and discussions on a wide variety of subjects pertaining to research and standards for materials.

Symposium on Electron Metallography. *Special Technical Publication No. 262. 1960. Cloth, 6 by 9 in., 134 pp. Price $4.25*

Subjects covered in this book include techniques for studying the morphology of phases in high temperature alloys, structure and growth of tin oxide, metallography of neutron irradiated steels, and dislocations in thin foils of stainless steel.

Symposium on Hydraulic Fluids. *Special Technical Publication No. 267. 1960. Cloth, 6 by 9 in., 104 pp. Price $3.75*

Discusses fire resistance and use of hydraulic fluids in automobiles, boats, aircraft and industry.

Literature Surveys on Influence of Stress Concentrations at Elevated Temperatures and the Effect of Non-Steady Load and Temperature Conditions on the Creep of Metals. *Special Technical Publication No. 260. 1960. Paper, 8½ by 11 in., 108 pp. Price $4.50*

Symposium on Education in Materials. *Special Technical Publication No. 263. 1960. Paper, 6 by 9 in., 56 pp. Price $2*

Contains chapters on the following subjects: ASTM views on engineering education; education in materials from an educator's viewpoint; industry's viewpoint on

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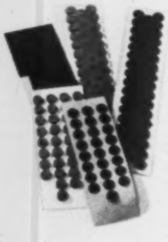

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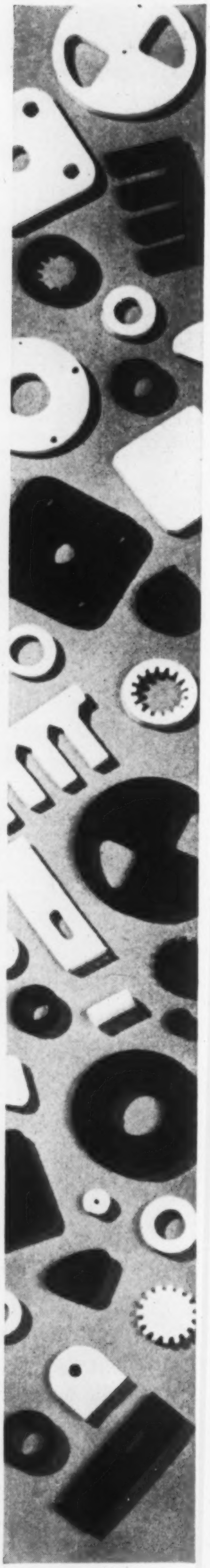

education in materials; future challenges of the design engineer to the metal engineer and their bearing on the metal engineer's education; education in engineering; nature and properties of materials; and viewpoint of the civil engineer.

Reports

Strength of rubber TENSILE TEST REPRODUCIBILITY OF ELASTOMERIC VULCANIZATES. *S. L. Eisler, Rock Island Arsenal. Sept '58. 29 pp. Available from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C. Price $2.70 (microfilm), $4.80 (photocopy) (PB 138408).*

Results indicate that the size of filler particles and the presence of undispersed curative particles, which probably produce areas of overcure, are the two most important factors affecting reproducibility of tensile tests on elastomeric vulcanizates.

Fabricating columbium FABRICATION OF PURE COLUMBIUM. *W. D. Klopp and W. Hodge, Defense Metals Information Center. Sept '59. 9 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 50¢ (PB 161184).*

Processing cermets TITANIUM CARBIDE-NICKEL CERMETS: PROCESSING AND JOINING. *J. Wulff, J. E. Cline and others, Massachusetts Institute of Technology. Dec. '53. 21 pp. Available from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C. Price $2.70 (microfilm), $4.80 (photocopy) (PB 144559).*

Titanium carbide cermets can be joined to high temperature alloys by vacuum diffusion. Fabrication of cermet parts can be done by cold forging cermet powder in a ductile envelope and subsequently sintering.

Research reports CUMULATIVE INDEX OF U. S. GOVERNMENT RESEARCH REPORTS: VOLUME 31 (JAN-JUNE 1959). *Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $1.*

Protecting molybdenum EVALUATION OF PROTECTIVE COATINGS FOR MOLYBDENUM NOZZLE GUIDE VANES. *J. R. Giancola, Wright Air Development Center. June '59. 47 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.25 (PB 151912).*

Thirty-seven molybdenum guide vanes with various coatings were evaluated for resistance to the effects of a jet engine exhaust stream at temperatures from 1860 to 1890 F. Results indicate that multilayer electrodeposited metallic coatings have the longest service life.

Corrosion resistant steel DEVELOPMENT OF A CORROSION-RESISTANT BEARING STEEL FOR SERVICE IN AIRCRAFT AT TEMPERATURES UP TO 1000 F. *G. Steven and T. V. Philip, Crucible Steel Co. of America. Oct. '59. 70 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.75 (PB 161338).*

Corrosion resistance has been added to the high initial hardness, adequate temper resistance (600-900 F), and good dimensional stability of type 440C stainless steel by modifying it with vanadium, tungsten, molybdenum and cobalt.

Fatigue test data EFFECT OF CHANGING CYCLIC MODULUS ON BENDING FATIGUE STRENGTH: PART 2. *A. A. Blatherwich and B. J. Lazan, University of Minnesota. May*

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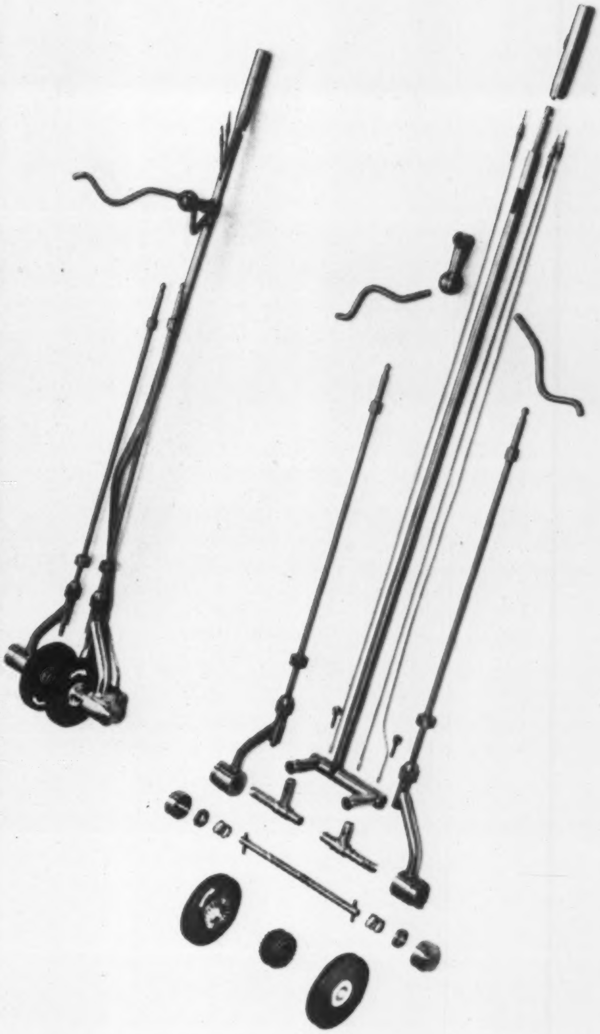

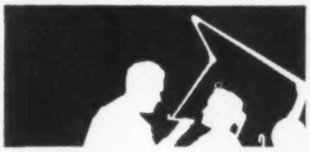

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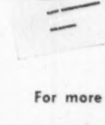

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'59. 34 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1 (PB 151853)

Comparing results of different types of fatigue tests involving cyclic strain hardening materials is meaningless because of changing stress distribution, according to this report. Forged bars of high purity aluminum were subjected to constant strain, stress and moment-amplitude tests to determine the influence of changing cyclic secant modulus on bending fatigue. Results are compared with results of axial fatigue tests and other investigations.

Carburized steels ATLAS, HARDENABILITY OF CARBURIZED STEELS. *1960. Climax Molybdenum Co., Div. of American Metal Climax, Inc., New York.*

Over 125 charts show the effect of cooling rates on the Rockwell hardness of carburized molybdenum, carbon, nickel-chromium, nickel-chromium-molybdenum and other steels.

Corrosion of alloys A STUDY OF THE CORROSIVE EFFECTS OF THE COMBUSTION PRODUCTS OF BORON CONTAINING FUELS ON SELECTED HIGH TEMPERATURE MATERIALS. *F. J. Loprest and S. J. Tunkel, Thiokol Chemical Corp. Sept '59. 331 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $5 (PB 161421)*

Polypropylene fibers A NEW ITALIAN ASSERTION IN THE TEXTILE FIELDS: POLYPROPYLENE FIBERS. *G. Natta. 1960. 16 pp. Available from SLA Translation Center, John Crerar Library, 86 E. Randolph St., Chicago. Price $2.40 (microfilm), $3.30 (photocopy) (No. 60-14118)*

Discusses the production, properties and uses of polypropylene fibers. Polypropylene was synthetized by Natta in 1954.

Materials research SIXTH MATERIALS REVIEW. *A. Lyem, U. S. Army Chemical Warfare Laboratories. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2.25 (PB 161463)*

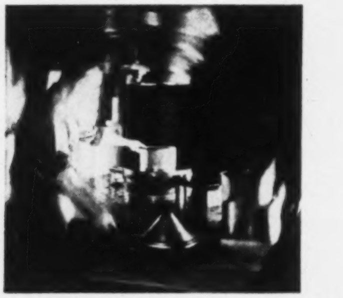
Information on important materials research here and abroad, principally in the polymer and plastics field.

Deposition of thin films RESEARCH ON THE PYROLYTIC DEPOSITION OF THIN FILMS. *F. V. Schossberger, S. Spriggs, F. Ticulka, E. Tompkins and E. Fagen, Armour Research Foundation. Oct '59. 45 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.25 (PB 161417)*

Describes the preparation of thin films by pyrolytic deposition and other means for potential use in composite molecular electronics.

Corrosion of metals CORROSION OF METALS IN TROPICAL ENVIRONMENTS: PART 4, WROUGHT IRON. *C. R. Southwell and others, U. S. Naval Research Laboratory. Oct '59. 20 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 50¢ (PB 151852)*

Information on corrosion of wrought iron, and mild, unalloyed structural steel after eight years' exposure in tropical environments. Greatest corrosion and pitting of the iron was noted after continuous immersion in sea water. Initial corrosion of wrought iron was greater in fresh water, but began decreasing after four years, virtually ceasing by the end of the eight-year test period. Both marine and inland atmospheres were more corrosive to wrought iron than to steel.



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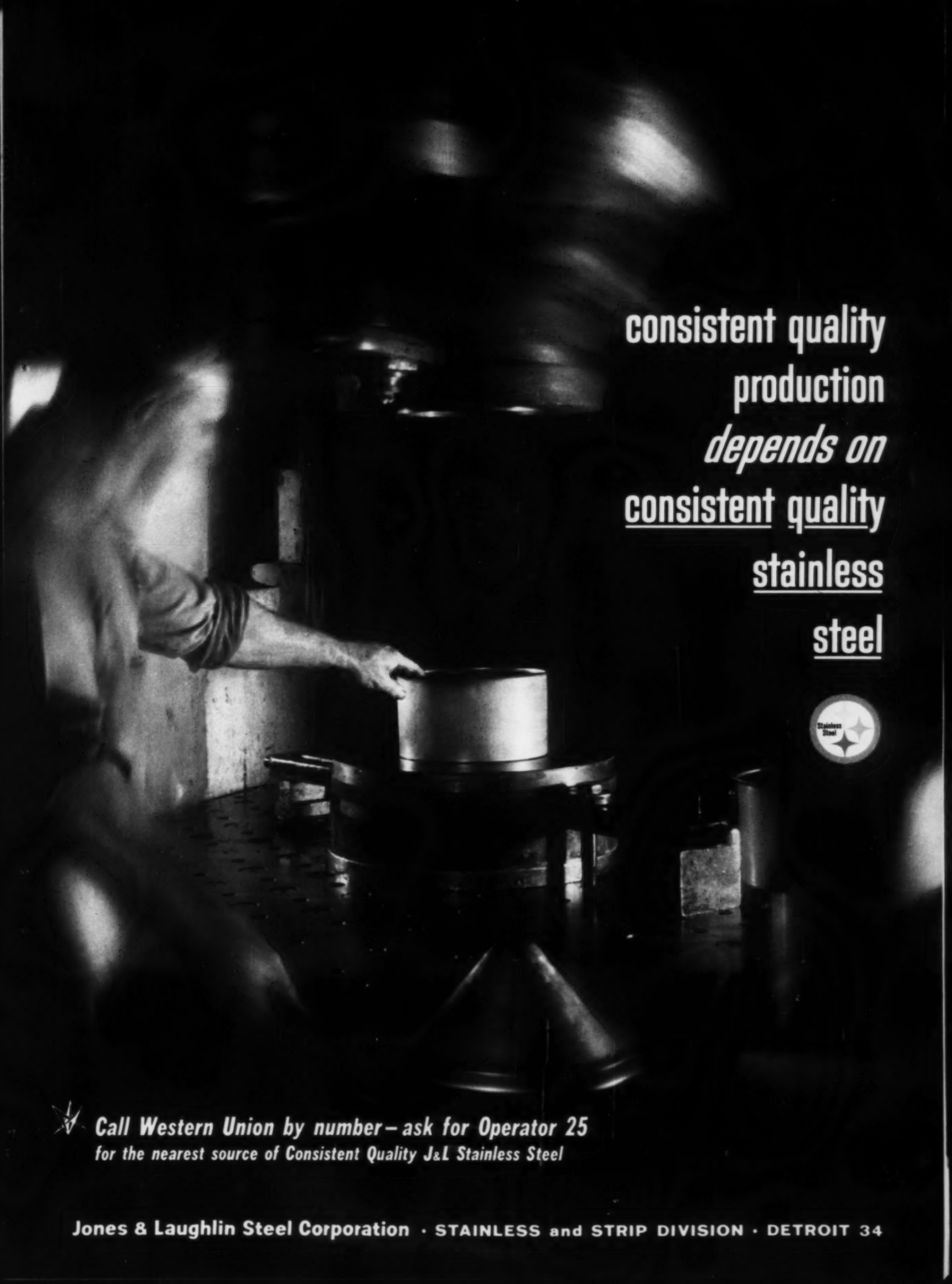
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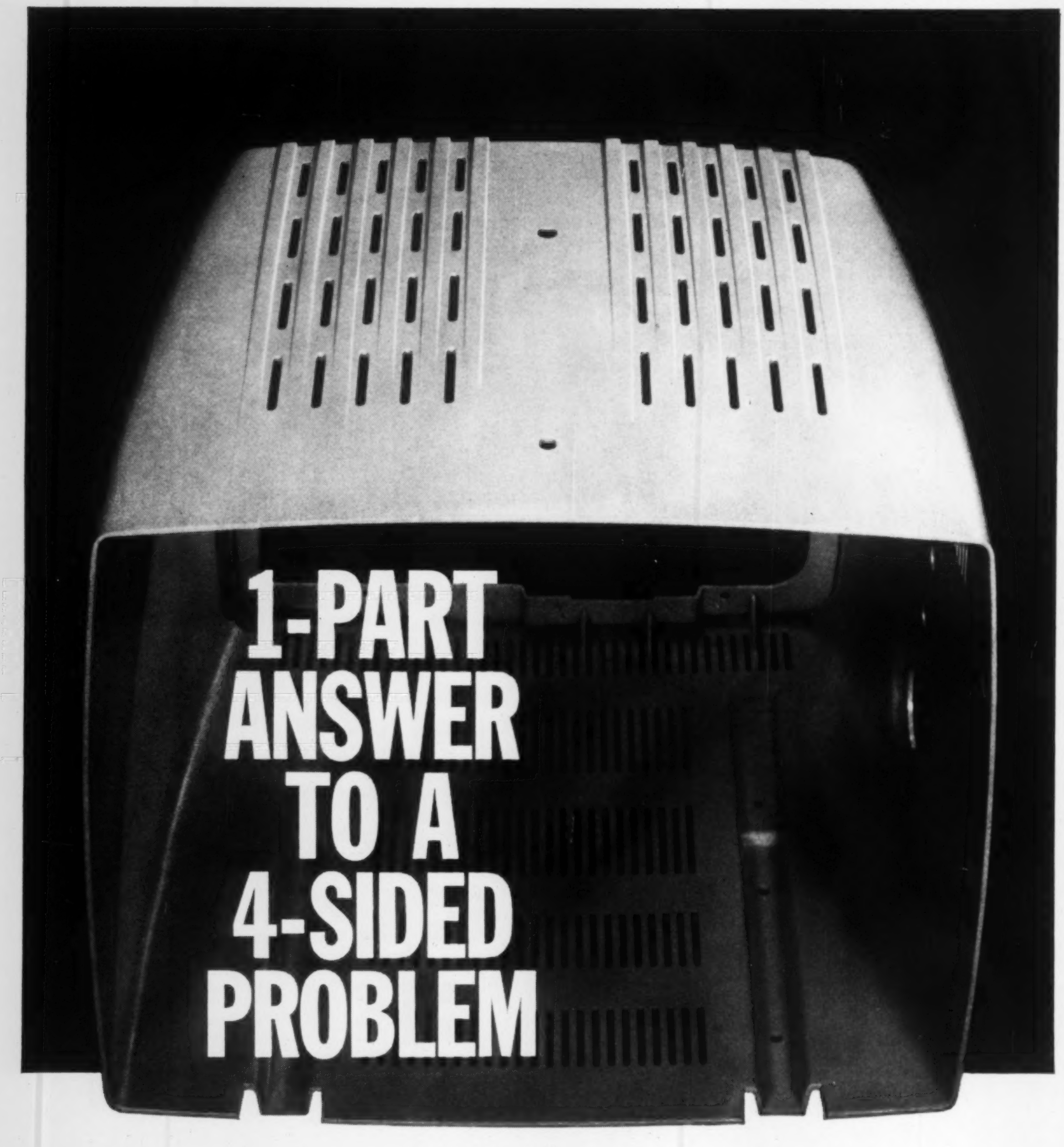


Just one shot on an injection press, and out comes this complicated 17-inch television cabinet weighing 1970 grams! Openings and grilles on all four sides required a mold opening in four directions. General American's ability to mold a cabinet like this means expanded opportunities in the use of plastics in all industries—since skilled die-makers working with production engineering experts assure the successful execution of the most demanding designs. Have you thought that perhaps your part or product could be produced more efficiently and economically in plastics? With greater eye-appeal? Techniques developed by years of molding experience, together with the unequalled facilities at General American provide a source upon which you can call—and depend.

In plastics, as in so many other areas, *it pays to plan with General American.*

Plastics Division
GENERAL AMERICAN TRANSPORTATION CORPORATION
135 South LaSalle Street · Chicago 3, Illinois
Offices in principal cities

PLASTICS DIVISION GENERAL AMERICAN TRADE MARK

For more information, turn to Reader Service card, circle No. 371

What's new IN MATERIALS

(cont'd from p 18)

TABLE 1—ELECTRICAL PROPERTIES OF CYANOCEL FILM
(2 Mils Thick, 73 F, 50% RH)

Dielectric Strength (short time), v/mil	
In Oil (2.5 mils thick)	1860
In Air (2.5 mils thick; 26% RH)	1440
Dielectric Constant[a]	
100 Cps	13.0
1 Kc	12.8
10 Kc	12.3
100 Kc	11.7
1 Mc	10.0
Dissipation Factor[a]	
100 Cps	<0.02
1 Kc	<0.02
10 Kc	0.02
100 Kc	0.04
1 Mc	0.12

[a] Lewis, C. W. and Hogle, D. H., *Jnl. Polymer Sci*, 21, 411, '56.

TABLE 2—PROPERTIES OF CYANOCEL MOLDINGS
(73 F, 50% RH Except As Noted)

PHYSICAL PROPERTIES	
Flexural Strength, 1000 psi	4.2
Modulus of Elasticity, 10^5 psi	3.2
Tensile Strength, 1000 psi	1.8
Elongation, %	1.11
Tensile Impact Strength, ft-lb sq in.	4.3
Rockwell Hardness	M15
Heat Dist Temp (264 psi), F	280
Flammability, ipm	1
Water Absorption (24 hr), %	2.6
Coef of Lin Ther Exp, per °F	5.2×10^{-5}
Weight Loss (48 hr at 220 F)	1.9
ELECTRICAL PROPERTIES	
Dielectric Constant	
60 Cps	18.8
10^3 Cps	15.6
10^6 Cps	12.6
Dielectric Constant (desiccated)	
60 Cps	16.8
10^3 Cps	14.8
10^6 Cps	12.5
Dissipation Factor	
60 Cps	0.165
10^3 Cps	0.039
10^6 Cps	0.180
Dissipation Factor (desiccated)	
60 Cps	0.048
10^3 Cps	0.019
10^6 Cps	0.125
Volume Resistivity, ohm-cm	6.0×10^9
Surface Resistivity, ohms	5.3×10^{11}
Insulation Resistance, ohms	1.0×10^{10}
Dielectric Strength (in oil), v mil	
Short Time	260
Step by Step	160
Arc Resistance	Poor

luminescent lamp produced by General Electric Co. The material is available from Cyanamid in development quantities at $27 per lb.

Properties

Two-mil cast film has a density of 0.043 lb per cu in. (1.2 gm per cu cm), a tensile strength of 5380 psi, elongation of 9% at break, and Young's modulus of 3.4 by 10^5 psi. Dielectric properties of the film are shown in Table 1.

Mechanical properties can be altered by incorporating plasticizers, such as bis(cyanoethyl)-phthalate. Plasticizers should have high dielectric constants and low dissipation factors.

Cyanocel can be molded at 390 F under 6000 psi pressure to provide a relatively strong molding which, under dry conditions, has the same basic dielectric characteristics as the films. Properties of moldings are shown in Table 2.

For more information, circle No. 611

Copper Alloy Resists Corrosion

American Brass Co., Waterbury, Conn. has announced the production and commercial availability of Cunisil-837, an alloy of 97.5% copper, 1.8% nickel and 0.6% silicon.

The company says the alloy has many of the desired qualities of silicon bronze. Its machinability rating, based on 100 for free-cutting brass rod, is approximately 40. A big use for the alloy will probably be in electrical equipment.

Properties, heat treatment

The new alloy has high tensile strength, high yield strength, high electrical conductivity (30 - 42% IACS as heat treated), and good corrosion resistance. It has a density

No. 18 of a series

Eastman 910 Adhesive solves another production bottleneck

Atkins & Merrill, Inc., industrial model makers, of South Sudbury, Massachusetts, produce quarter-scale cut-away models of the famous Pratt & Whitney J-57 TurboWasp jet aircraft engine.

Highly detailed, the model contains several compressor and turbine rotors, driven by concealed motors. More than 1,600 small die cast zinc alloy blades are attached to zinc alloy rotors.

Fastening the blades posed a problem, however, as soldering or welding generated excessive heat, causing the blades to warp.

The problem was solved with high-strength Eastman 910 Adhesive. It sets quickly without heat, requires only contact pressure. To date, more than 70,000 blades have been bonded.

Eastman 910 Adhesive is making possible faster, more economical assemblyline operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is used as it comes. No mixing, no heating. Simply spread the adhesive into a thin film between two surfaces. Light manual pressure triggers setting. With most materials, strong bonds are made within minutes.

What production or design problems can this unique adhesive solve for you?

Eastman
910
Adhesive

Bonds Almost Instantly with Contact Pressure No Heat... No Catalyst...

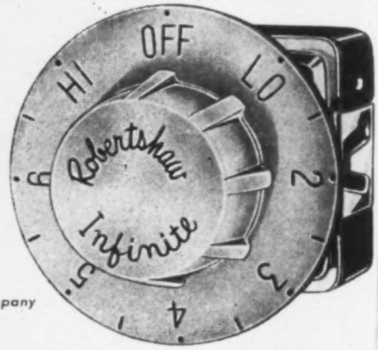
For a trial quantity (1/3-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9110 Dunbar Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. E-10, Kingsport, Tenn. (Not for drug use)
See Sweet's 1960 Prod. Des. File, 7/E

For more information, circle No. 361

Chace
THERMOSTATIC BIMETAL
ACTUATES ANOTHER
PRECISION PRODUCT...

Robertshaw
MR CONTROLS

Electric
Infinite
Control



A product of
Robertshaw-Fulton Controls Company
Indiana, Pennsylvania

Range manufacturers wax enthusiastic over this new development from Robertshaw. And well they might, because this is one Infinite Control designed with the manufacturer in mind! For instance: the new model INF (pictured) is approximately the same size as an ordinary five-heat rotary switch, making it fully interchangeable at any time in the production cycle. The range builder needs to stock only one type control for all elements.

The Robertshaw Electric Infinite Control model INF turns clockwise or counterclockwise and is equipped with three indexing positions: "Off," "High," and "Low." In the "High" position, the control is energized continuously. At other settings it delivers the selected input level under the control of a bimetal timer. A second bimetal is employed as an ambient temperature compensator to neutralize the effect of ambient temperature changes on the control bimetal. *Both* of these important components are made of Chace Thermostatic Bimetal.

By specifying the inclusion of Chace Thermostatic Bimetals in "the most advanced concepts in electric controls," Robertshaw joins many manufacturers who know they can depend on Chace. This dependability is born of more than 30 years of manufacturing only one product: precision bimetal. Any manufacturer can be sure his name is safe on the outside with Chace Thermostatic Bimetal on the inside of his product.

OUR NEW INFORMATION BOOKLET IS READY NOW!

If your new product is approaching the design stage, send for "Information Booklet". It contains design data, illustrations and applications for more than 30 types of Chace Thermostatic Bimetal. Chace bimetal is available in stripes, coils and in completely fabricated elements of your design.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

For more information, turn to Reader Service card, circle No. 342

MECHANICAL PROPERTIES OF CUNISIL-837

Min Tensile Strength, psi	90,000
Min Yield Strength (0.5% extension under load), psi	70,000
Min Elongation, %	8
Angle of Bend on Radius Equal to Diameter, deg	90

of 0.322 lb per cu in., and its linear coefficient of thermal expansion is 0.0000098 per °F over the temperature range 68 to 572 F.

The developer says most of the nickel and silicon in the heat treated alloy are present as an intermetallic compound of nickel silicide, and it is the precipitation of nickel silicide in the form of submicroscopic particles by a relatively low temperature heat treatment (approx. 840 F) that accounts largely for the distinctive properties of the alloy.

Prior to the hardening heat treatment, the alloy is brought to a proper condition for hardening by giving it a solution anneal at about 1470 F, and then quenching. The developer says that at this stage the alloy is quite soft and in a condition for drastic cold working.

Availability

The new copper alloy is made in round rod, with or without the final precipitation hardening heat treatment. The rod is supplied in straight lengths in diameters from 3/16 to 1 in., and in coils 3/16 to ⅝ in. in dia. **KEY NO. 612**

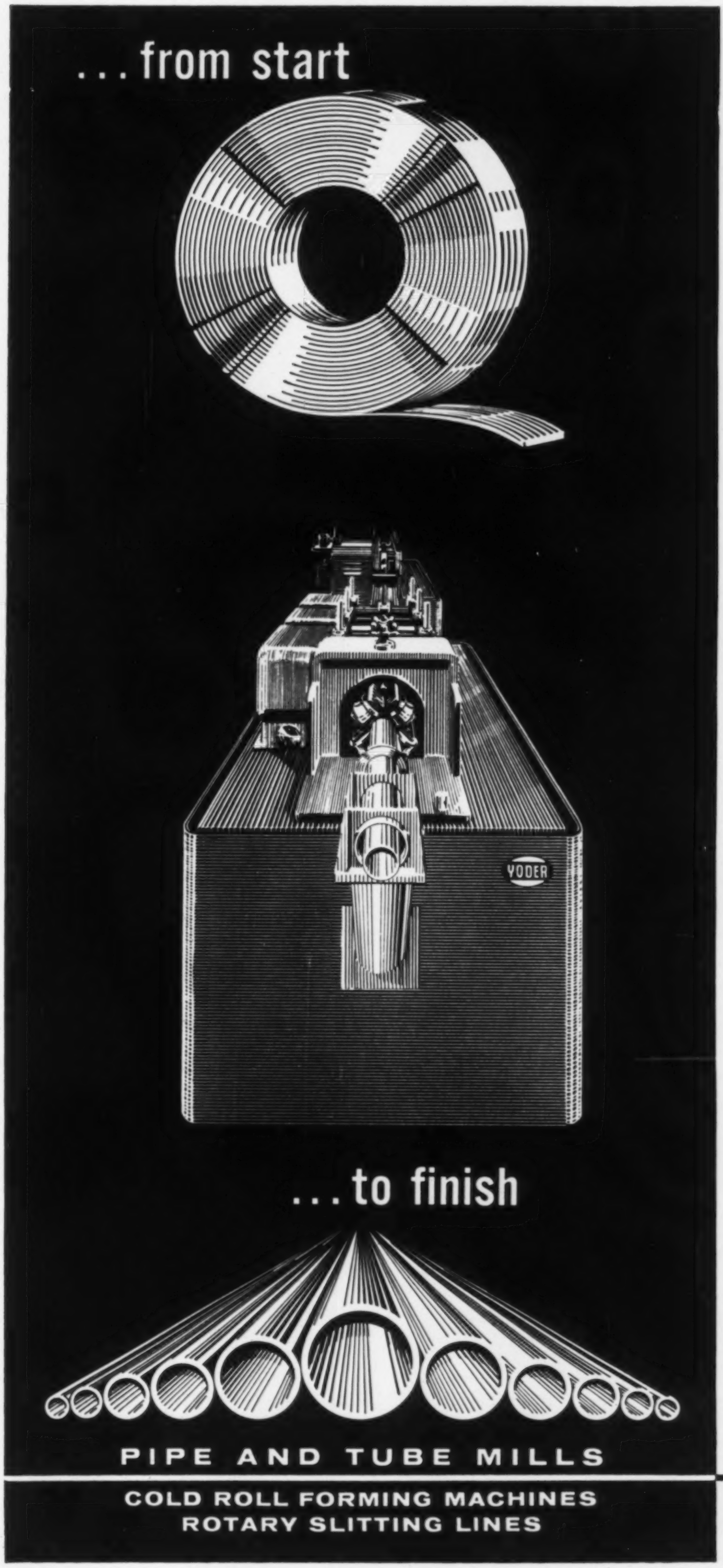
Polyethylene Resins Extruded Into Pipe

Three new polyethylene compounds are available for extrusion into pipe.

The materials are designed to meet the requirements for Type II and Type III polyethylene pipe as defined in the proposed revision of commercial standard CS 197-59. The standard was prepared by the Society of the Plastics Industry.

All three materials carry the National Sanitation Foundation's seal of approval for transmission of potable water.

DGDA-2033 Black 4865 is a Type III, higher density polyethylene pipe compound introduced by Union Car-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YODER
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PIPE AND TUBE MILLS
COLD ROLL FORMING MACHINES
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A Yoder engineer can help you realize remarkable savings in the manufacture of ferrous or non-ferrous pipe or tube. He can show you how present Yoder Pipe or Tube Mill owners are increasing production, lowering over-all manufacturing costs and reducing downtime through use of Yoder Mills.

If your products require pipe or tubing from 5/16" to 26" diameters, Yoder Pipe or Tube Mills and accessory equipment can help you produce your product more efficiently to meet today's competitive markets.

In addition to Pipe or Tube Mills, Yoder engineers and builds a complete line of Slitting equipment and Cold Roll-Forming Machinery.

For complete information on Yoder Tube Mills . . . send for the fully illustrated, 64 page Yoder Tube Mill book . . . it is yours for the asking.

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ENGINEERING
YODER
MANUFACTURING

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which stack
would YOU use for
corrosive fumes?

8888-CC

This stainless steel stack failed after only 6 months in corrosion service!

Over 2 years old . . . yet this Duracor stack shows absolutely no signs of attack inside or outside!

DURACOR VENTILATING SYSTEMS PROVIDE LASTING CORROSION RESISTANCE AT LOW COST!

Performance-proven Duracor Ventilating Systems and components provide outstanding resistance to attack from all types of corrosive fumes. These high-strength systems are corrosion-proof throughout . . . are practically immune to weathering . . . require only minimum support! Best of all, Duracor construction can save you up to 30% on your initial investment . . . and it's maintenance-free! Ceilcote engineers will design a complete Duracor system to meet your special requirements . . . or modify your present system to permit gradual conversion to Duracor. Fabricated to meet customer specifications . . . or assembled from stocked component parts . . . Duracor Ventilating Systems can be easily installed by regular plant maintenance crews or by experienced Ceilcote installation personnel. Write today for the new Ceilcote catalog.

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For more information, turn to Reader Service card, circle No. 340

bide Plastics Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17. The compound is said to have favorable long-term stress properties, combined with easy processability in conventional equipment at high extrusion rates. **KEY NO. 613**

Tenite 2521 E-60099 is a Type II, medium density compound introduced by Eastman Chemical Products, Inc., 260 Madison Ave., New York 16. It sells for 35¢ per lb.

Tenite 2811 E-80010 is a Type III, higher density compound also introduced by Eastman Chemical. It sells for 38¢ per lb.

Both Tenite formulations are said to yield polyethylene pipe at fast production rates with smooth, glossy surfaces both inside and outside.
KEY NO. 614

Compound Cleans, Phosphates Metals

Development of a new phosphating compound for simultaneous cleaning and phosphating of iron, steel and zinc has been announced by Turco Products, Inc., 24600 S. Main St., Wilmington, Calif.

Called Paintite, the compound is said to produce a light, tight, smooth and uniform phosphate coating that assures paint adhesion and prevents rapid post-rusting of metals before painting. It is said to be extremely low foaming, low sludging and free rinsing, and to require a minimum of temperature control when used between 140 and 180 F.
KEY NO. 615

Irradiated Tubing Fits Over Irregular Shapes

A new irradiated polyolefin tubing heat shrinks to form a tight bond over irregular shapes. Called Hyshrink, it is available from Sequoia Wire & Cable Co., a subsidiary of Anaconda Wire & Cable Co., 25 Broadway, New York 4.

The tubing is supplied in a variety of colors, in sizes from 0.050 to 0.348 in. i.d., in lengths of 4 ft.

How tubing is applied

The flexible tubing can be slipped easily in its expanded form over

A new family
of materials
to meet
special problems
•

SHOCK
STRESS
ABRASION

AMSCO® ALLOYS

In addition to austenitic manganese steel castings—long known for their exceptional service life in mining, construction, quarrying and milling applications—Amsco now offers *seven* other ferrous alloy materials. These include specially alloyed manganese steels, chrome moly steels, high strength alloyed steels and alloyed cast irons.

Each has particular advantages for specific service requirements, involving various combinations of impact, stress and wear. Check the brief facts on these alloys below. Then call in an Amsco sales engineer to assist in selecting the *one best* material to meet your application needs.

AMSCO ALLOY DESIGNATION	DESCRIPTION AND USES	MECHANICAL PROPERTIES
MY	Heat-treated, chromium alloyed manganese steel ... for use in light-to-medium weight castings requiring modest improvement in growth and distortion, and increased stiffness.	tensile strength .... 120,000 psi yield strength .... 56,000 psi elongation .... 45% reduction of area 30%
MML	Heat-treated, molybdenum alloyed manganese steel ... for castings requiring improved weldability, for extremely heavy metal sections, and castings exposed to excessive heating environments.	tensile strength .... 120,000 psi yield strength .... 52,000 psi elongation .... 50% reduction of area 40%
MMH	Heat-treated, molybdenum alloyed manganese steel ... for use in castings requiring optimum mechanical properties and wear resistance. Provides improved stiffness and resistance to peening and flow.	tensile strength .... 120,000 psi yield strength .... 65,000 psi elongation .... 20% reduction of area 18%
CML	Heat-treated, air-hardening chrome-moly steel ... for casting applications involving scouring or grinding wear. Suitable for more complex casting designs.	tensile strength .... 155,000 psi yield strength .... 130,000 psi elongation .... 10% reduction of area .... 15% hardness .... 275-375 BHN
CMH	Heat-treated, air-hardening chrome-moly steel ... exhibits potentially improved wear resistance over CML (above), when shock loading is not sufficiently severe to cause breakage.	tensile strength .... 155,000 psi yield strength .... 130,000 psi elongation .... 6% reduction of area .... 7% hardness .... 300-400 BHN
CS	Martensitic, multiple alloy steel with chromium, nickel and molybdenum ... combines high mechanical strength with good abrasion and wear resistance.	tensile strength .... 220,000 psi yield strength .... 195,000 psi elongation .... 8% reduction of area .... 20% hardness .... 300-500 BHN
HC	High chromium cast iron ... provides outstanding abrasive wear resistance, where impact force is low but particle velocity and scouring forces are high.	tensile strength .... 60,000 psi transverse strength .... 7,000 lbs. deflection .... 0.12 in. hardness .... 400-600 BHN

For further information
—write for technical bulletin on
"Amsco Ferrous Alloy Castings".

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American Manganese Steel Division • Chicago Heights, Illinois

For more information, turn to Reader Service card, circle No. 327

From the SILICONES MAN...

NEW WAYS TO KEEP HOME APPLIANCES FROM WEARING OUT THEIR WELCOME

When a new home appliance joins your family circle today, chances are that a UNION CARBIDE Silicone makes it more efficient. Silicone rubber gaskets stay flexible when icy cold, sealing your refrigerator doors tighter. Because silicones scorn heat, they're also the best seals for oven doors and pressure cooker lids. Hot cakes and fried eggs refuse to stick to silicone-resin-treated electric griddles. Silicone insulation resistant to heat and electricity is at the very heart of steam iron and electric frying pan wires and gaskets. This insulation has long served radio and TV sets, of course. But you may not know the part it plays in the motors of vacuum cleaners, fans, mixers. Here, high heat resistance lets motors run hotter, permitting smaller size and longer life, without sacrificing power. Radio transistors are made from a basic silicone chemical, as are the bonding materials that help wed glass to plastics for the linings of automatic dishwashers. The complex plastic parts of loudspeakers slip cleanly from molds, thanks to silicone release agents. And silicone-resin-base paints cover your home heating plant, which in turn is controlled by an electric clock lubricated for life with silicone oil. Yet the appliance industry is only one that has benefited from silicones. Yours can, too. To discover how, call your UNION CARBIDE Silicones Man. Silicones Division, Dept. JM-0003, Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y.

Unlocking the secrets of silicones

Rubber, Monomers, Resins, Oils and Emulsions

UNION CARBIDE

SILICONES

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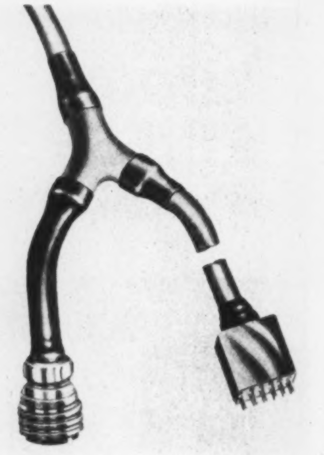
For more information, turn to Reader Service card, circle No. 446



Cable harness *shows four possible applications (dark areas) for irradiated tubing.*

terminals, connectors, wire, cable, conduit and other electrical and electronic parts. Upon application of heat (275 F), the tubing shrinks in diameter to form a strong mechanical bond.

According to the producer, heating will not affect flexibility of the irradiated tubing. The product is said to have excellent shelf life and will remain at its expanded diameter until heated.

Tubing is flame retardant

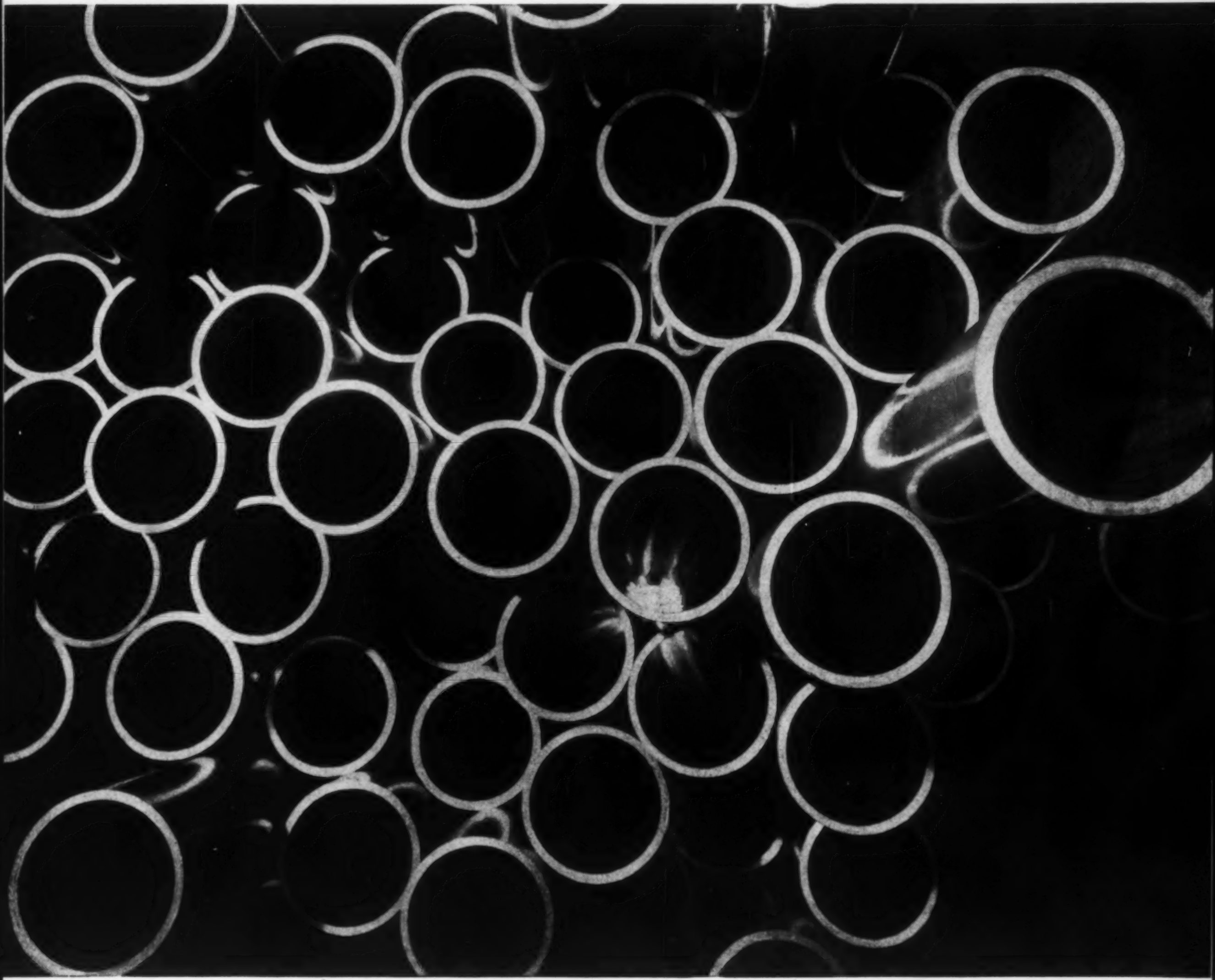
The new product is flame retardant, thermally stable, and resistant to most chemicals, JP-4 jet fuel and Skydrol hydraulic fluid.

The tubing is also resistant to fungus growth, gives off no toxic fumes when heated, shows a weight increase of 0.01% or less after immersion in water, and remains flexible and strong over the temperature range 67 to 275 F. Within this temperature range the applied tubing will not melt, harden, flow, run, crack or blister, according to the producer.

Sequoia's irradiated polyolefin

AWARDS COMPETITION — Entries for the 5th annual Awards Competition for the Best Use of Materials in Product Design are due Feb 1, 1961. See p 123 for details.

This mark tells you a product is made of modern, dependable Steel.



Look at the dimensional accuracy and smoothness

You can reduce the costs and processing time of parts-making by using USS National Electric-Resistance Welded Mechanical Tubing. It eliminates drilling operations. It lets you replace drills with simple, less expensive boring tools. Mechanical Tubing reduces tool wear and tool changes.

USS National Electric Welded Mechanical Tubing is an ideal load-carrying member. It resists bending stresses equally in all directions and gives you a superior cross section. It absorbs and localizes shock. In torsion, it provides better material distribution. And for a given weight, mechanical tubing withstands more load than other sections.

USS National Electric Welded Mechanical Tubing is available in cold-drawn or hot-rolled sizes ⅜″ thru 5½″ and in wall thicknesses .035″ to .250″. It can be obtained from National Tube Distributors located throughout the country. They will gladly show you how to use USS National Welded Mechanical Tubing in your next application. *See your USS National Tube Distributor.*

USS and National are registered trademarks

**National Tube
Division of
United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division
United States Steel Export Company, New York

For more information, turn to Reader Service card, circle No. 411

To solve your toughest stripping problem

ask Oakite

OVER 50 YEARS CLEANING EXPERIENCE • OVER 250 SERVICE MEN • OVER 160 MATERIALS

STRIP
PAINT

Strip any type of paint fast . . . even epoxies . . . with modern Oakite strippers

Even your toughest paint-removal problems can be solved with Oakite strippers. A dozen alkaline and solvent-type removers and additives are available to satisfy all needs. In the fastest, most economical way, they enable you to get a clean, smooth surface for repainting.

Oakite strippers are available to fit every method of application including soak tank . . . brush . . . steam gun. Look at these typical results:

- Stripping rejected television cabinets of paint and phosphate coating took 25 minutes before the proper Oakite material eliminated three steps, slashing time to 10 minutes.
- An auto parts maker says that a continuous cycle of 1 minute and 50 seconds "works like a charm stripping paint and incidental rust from rejects and hooks."
- Brass plated steel parts were stripped of their epoxy finish in a matter of minutes.

For stripper recommendation, just tell us your paint removal problem—the base metal, the paint type, number of paint layers, size of items to be stripped. Or ask your local Oakite man. Send for bulletin. Oakite Products, Inc., 26 Rector Street, New York 6, N. Y.

it PAYS to ask Oakite

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SCIENCE

over 50 Est. 1909 years' leadership in industrial cleaning

For more information, turn to Reader Service card, circle No. 417

tubing is similar to W. R. Grace's Cryovac irradiated polyethylene film introduced earlier this year (see M/DE, May '60, p 218).

KEY NO. 616

Urethane Elastomers Sold in Various Grades

A new urethane elastomer is being supplied in a variety of formulations ranging from very soft to hard, and from flexible to rigid in construction.

The elastomer, called Uscothane and developed by U. S. Rubber Co., 1230 Avenue of the Americas, New York 20, does not differ materially from other urethanes now on the market: the difference lies in the broad scope of compounds offered, according to the developer.

Properties

U. S. Rubber says the new material's properties are controlled not only by polymer chemistry, but also by time and temperature of cure, and by mixing conditions. The material can be made to fit an almost infinite number of exacting performance requirements by varying these conditions of preparation.

Tests show the material has good resistance to ozone attack, and is impervious to oil and most common commercial solvents. It can be used over the temperature ranges of —30

Air car *rides on a cushion of air that is directed straight down to the ground by a urethane rubber skirt that runs the circumference of the vehicle.*

TubeXperience in action

STST*

*Superior Tool Steel Tubing

ODDS: 1000 TO 1 TO CUT COSTS, IMPROVE PERFORMANCE IN 1001 DIFFERENT APPLICATIONS

Superior tool steel tubing is an excellent material for tools, but equally good for 1001 other applications. Odds are that it will cut costs and improve performance wherever it is used. Type E-52100, an oil hardening grade of high-carbon and chromium alloy steel, has been widely used for such diverse applications as thread guides on hosiery knitting machines, nylon yarn guides, ball bearing races, nozzles for blast cleaning equipment, gear and pinion parts, dental instruments and extrusion mandrels. Type E-1095, a high-carbon steel tubing, is serving as applicators for jewelers' oilers, leather and paper punches, and surgical instruments.

Perhaps you have an application that can benefit from high strength and hardness, good wear resistance, abrasion resistance, shock resistance, and notch toughness. In that case, consider Superior tool steel tubing before you go any farther. It could give you a better product at a lower cost. Send for Data Memorandum #14, a handy guide to your thinking. Superior Tube Company, 2006 Germantown Ave., Norristown, Pa.

Steel

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

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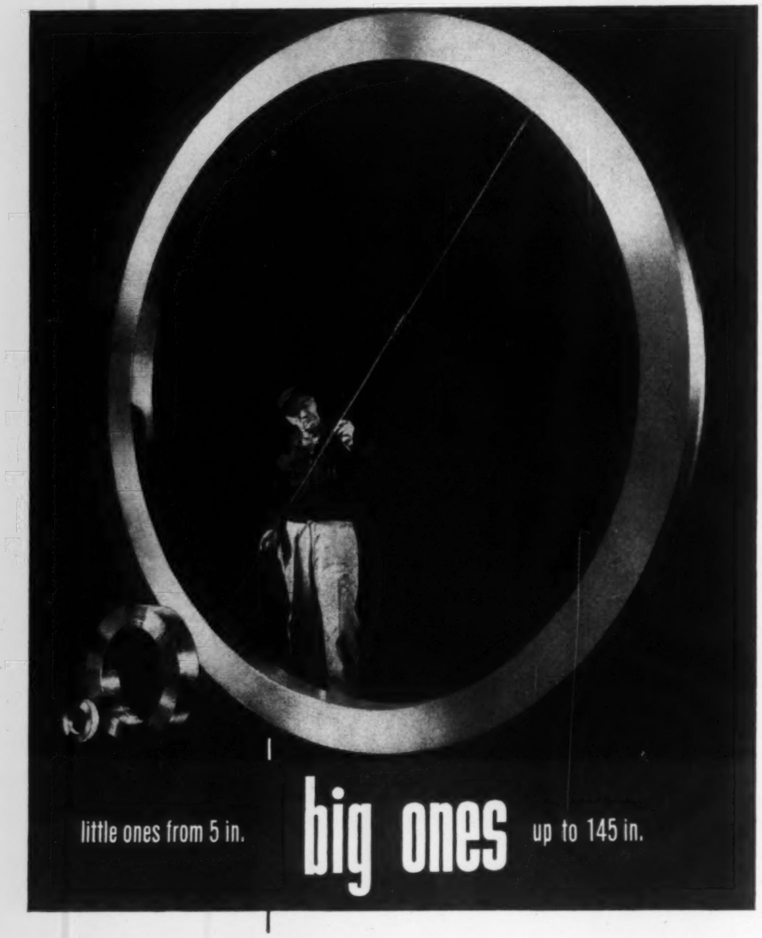
How to buy steel rings . . .



consult with experienced maker

Find out about his background . . . experience . . . manufacturing facilities . . . how close he can come to meeting your specifications . . . what engineering assistance he can provide.

put your plans in his hands

When you have found this experienced, reliable supplier, send him your drawings. Give him complete details on materials, shape, tolerances you require, nature of application, and the performance you expect.

then let him assist you

If Edgewater is your choice, you will find that we will follow your specifications exactly. If required, we can furnish engineering assistance and suggest the material, shape and size to give you the ultimate in performance and economy.

want more details? Write for the Edgewater brochure, which describes our facilities, know-how, and range of sizes and shapes.

Edgewater Steel Company
P. O. Box 478 • Dept. MDE • Pittsburgh 30, Pa.

For more information, turn to Reader Service card, circle No. 362

to 250 F in dry service and −30 to 160 F in wet service.

Product used on air car

A recently introduced air car (see accompanying photo) uses the new material as a skirt around the circumference of the vehicle. Skirts made of the material have lasted more than three months during a recent testing program, replacing conventional rubber skirts that wore out daily from constant abrasion, tearing and gouging as the vehicle passed over gravel, concrete and other abrasive materials.

Other uses foreseen for Uscothane include chute linings, scrapers, rings, bumper pads, belt covers, caster wheels, power transmission belting, traction cleats, friction drives and gears.

Several formulations sold as stock items

For experimental work, U. S. Rubber is offering several formulations of the urethane elastomer as stock items. They include standard formulations of the elastomer in 1, 2 and 4-in. dia rods and in 3 by 10-ft fabric-backed slab stock, ¼ in. thick. Rods of a special compound with low coefficient of friction are also available.

The material can be bonded to almost any fabric and to many metals in sheet or shaped forms. The developer says successful metal-backed constructions have been made with aluminum, cast iron and steel.

KEY NO. 617

Indium-Clad Aluminum for Semiconductors

Aluminum preforms clad on both sides with indium are available for semiconductor "P" junctions from Accurate Specialties Co., Inc., Hackensack, N. J.

Melting indium onto the aluminum blank is said to eliminate the troublesome oxide films formed in mechanical bonding. Indium-aluminum alloys are desirable junction materials because introduction of aluminum into germanium crystals improves emitter efficiency. An oxide film makes it very difficult to wet the germanium.

In the metallurgical bonding method, the indium cladding melts

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **What a solvent cement can do**
- **Something new in electrical insulation**
- **A bulletin on plastics**

Stuck?

A good adhesive does a lot more than stick two things together. You can use today's solvent-type adhesives to:

- smooth out surface contours (as in brake linings and in jet aircraft skins, where adhesives can eliminate the need for projecting rivets);
- distribute stress uniformly over a surface, rather than concentrating it at welded or riveted points;
- build up large structural members from many small components;
- reduce galvanic action between dissimilar metals, and so lessen the risk of corrosion.

One super-sticker in this class sets with only contact pressure and at room temperature; adheres very well to metal, wood, phenolic laminates, glass, and rubber. Block shear tests show 4500 psi at room temperature, and tensile strength is 10,000 psi. The cement has excellent resistance to all ordinary solvents, water, oils, alkalies, and acids; has high capillary attraction and does not shrink.

We don't make adhesives. We do make heat-setting phenolic resins that give many of the newer adhesives more gripping power and more *permanence*. Next time you have a fastening problem, give these new solvent-type adhesives a chance to show you what they can do.

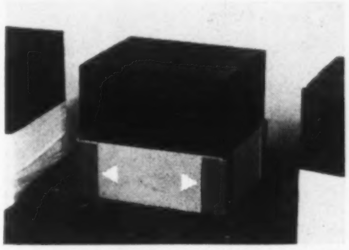
Stock insulation shapes

This insulation idea solves three engineering problems at once in a dry-type transformer. You'd find the same approach helpful in a circuit breaker, a panel, or other heavy-duty electrical gear.

See the plastic angle pieces (below)? They insulate the corners of the laminated steel core from the windings, at the high-stress areas. They take the place of roll-formed fiber. Advantages:

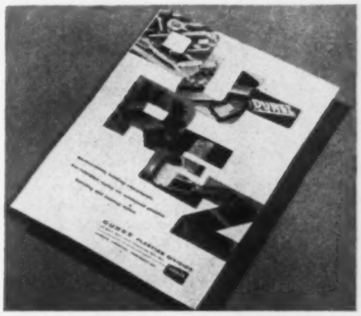
1. Greater mechanical strength. This ends cracking or breaking of insulation when windings are forced into position.
2. Better resistance to moisture. The insulation doesn't swell or shrink, maintains its dielectric strength under the clammiest conditions.
3. Higher heat resistance. The angle is made with glass-reinforced Hetron,® our inherently heat-resistant polyester resin. It meets NEMA GPO-1 specifications, and has UL-recognized flame retardance. It is designed for equipment operating at Class B temperatures (266° F.).

Now for the clincher. You can get flame-retardant structural insulation like this *from stock*—in a wide range of cross-section shapes including channels, in widths up to $9\frac{21}{32}$ inches, lengths to 76 inches.



PRECISION WELDER AND FLEXOPRESS CORP.

You get them not from us but from the manufacturer, The Glastic Corporation, 4321 Glenridge Road, Cleveland 21, Ohio. The Glastic people will be glad to send you details on stock channels and angles if you write to them.



Facts without a file

What does a man do when he wants to know more about Durez plastics?

He looks in Sweet's File. There he finds eight pages packed with the what, how, when, where, and why of using Durez materials—phenolic and diallyl phthalate molding compounds, Hetron polyester resins, phenolic resins.

What if he hasn't got Sweet's File handy? He sends us the coupon below, requesting Durez *Bulletin D400*. The same fact-filled eight pages come to him posthaste.

For more information on Durez materials mentioned above, check here:

☐ Phenolic resins (12-page bulletin listing applications)

☐ Hetron fire-retardant polyester resins (data file, including names of fabricators)

☐ Durez plastics *(Bulletin D400)*

Clip and mail to us with your name, title, company address. *(When requesting samples, please use business letterhead)*

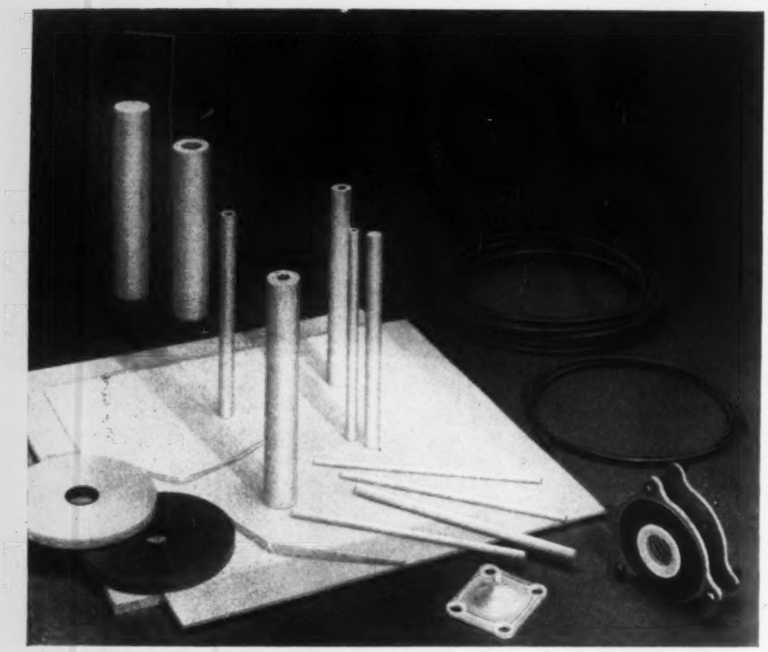
DUREZ PLASTICS DIVISION

1410 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

For more information, turn to Reader Service card, circle No. 359



Standard forms or specialized parts, R/M supplies them all in production quantities — according to *your* schedule. New bondable R/M "Teflon" extends the design horizons for this remarkable material, without degrading its other properties. Ask about it.

For design assistance, for production certainty... CALL R/M FOR TEFLON*

No need to restate the unique combination of electrical, chemical and physical properties of "Teflon." You *know* that for many parts calling for high dielectric strength or for resistance to heat and most chemicals, there simply is no substitute.

Big questions in your mind, then, are *where to get "Teflon" fast* and *who can best meet your specs.*

On both counts, the answer is R/M. A pioneer in the processing of "Teflon" into sheets, rods, tubes, hose, tape and machined specialties, R/M offers the designer a *complete "Teflon" service* — a service that can help assure efficient production of end products and optimum performance of critical components.

It will pay you to talk "Teflon" with R/M. Call your nearest R/M district office (listed below) or write Plastic Products Division, Raybestos-Manhattan, Inc., Manheim, Pa.

*Registered trademark for Du Pont fluorocarbon resin

R/M

PLASTIC PRODUCTS DIVISION
RAYBESTOS-MANHATTAN, INC.
Manheim, Pa.

BIRMINGHAM 1 • CHICAGO 31 • CLEVELAND 16 • DALLAS 26 • DENVER 16 • DETROIT 2
HOUSTON 1 • LOS ANGELES 58 • MINNEAPOLIS 16 • NEW ORLEANS 17 • PASSAIC • PHILADELPHIA 3
PITTSBURGH 22 • SAN FRANCISCO 5 • SEATTLE 4 • PETERBOROUGH, ONTARIO, CANADA

SPECIALISTS IN ASBESTOS, RUBBER, ENGINEERED PLASTICS, SINTERED METAL

For more information, turn to Reader Service card, circle No. 428

first at 750 F while protecting the aluminum from oxide formation. It then carries the dissolved aluminum into the germanium crystal interface.

The new tri-clad material is available in preforms, such as ultra-precise disks and washers, with a wide variety of cladding thicknesses.

KEY NO. 618

Vinyl Extrusions

Crane Plastics, Inc., 500 Hutton Pl., Columbus 15, Ohio says it is the first custom plastics extruder to develop and perfect production techniques for making multi-hollow, high impact, rigid vinyl extrusions. Details as to how the hollow plastics parts are made have not been revealed.

One such product is an extrusion with six hollow sections. It is used as a frame for windows and doors, replacing conventional wood and metal frames. Crane says the extruded vinyl frames do not warp, swell, fade or stain. They also operate smoothly and quietly, and have good chemical and impact resistance.

Crane says it also makes hollow and multi-hollow extrusions out of polyethylene, cellulose acetate, acrylic, polypropylene, ethyl cellulose, polystyrene and other plastics.

KEY NO. 619

Mica Insulation High in Dielectric Strength

A new mica electrical insulation is said to have 150% greater dielectric strength than either mica papers or built-up mica.

Developed by the Insulating Materials Dept. of General Electric Co., Schenectady, N. Y., the new insulation consists of silicone-bonded mica mat sandwiched between layers of silicone-varnished glass cloth.

The mica insulation has a dielectric strength of 1400 v per mil and is designed for both Class F (310 F) and Class H (360 F) applications. It is expected to be used primarily as slot insulation in a. c. motors, and as layer insulation in transformers.

The mica insulation has a cut-

KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Thermal Stress-Relieving of Alloy Steels

In the production of alloy steel bars and parts made of alloy steel, stresses are sometimes set up, and these stresses must be relieved before optimum results can be expected. Two general types of stress-relieving are practiced—thermal and mechanical. In this discussion we shall consider only the former.

There are several important reasons for thermal stress-relieving. Among these are the following:

(1) The first and most fundamental purpose is to reduce residual stresses that might prove harmful in actual service. In the production of quenched and tempered alloy steel bars, machine-straightening is necessary. This induces residual stresses in varying degrees. Bars are usually stress-relieved after the straightening operation. When the bars are subjected to later processing that sets up additional stresses, subsequent stress-relieving may be necessary.

(2) A second major purpose of thermal stress-relieving is to improve the dimensional stability of parts requiring close tolerances. For example, in rough-machining, residual stresses are sometimes introduced, and these should be relieved if dimensional stability is to be assured during the finish-machining.

(3) Thermal stress-relieving is also recommended as a means of restoring mechanical properties (especially ductility) after certain types of cold-working. Moreover, it is required by the "safe-welding" grades of alloy steels after a welding operation has been completed.

Alloy bars are commonly stress-relieved in furnaces. Temperatures under the transformation range are employed, and they are usually in the area from 850 deg to 1200 deg F. The amount of time required in the furnace will vary, being influenced by grade of steel, magnitude of residual stresses caused by prior processing, and mass effect of steel being heated. After the bars have been removed from the furnace, they are allowed to cool in still air to room temperature.

In the case of quenched and tempered alloy bars, the stress-relieving temperature should be about 100 deg F less than the tempering temperature. Should the stress-relieving temperature exceed the tempering temperature, the mechanical properties will be altered.

Items other than bars (parts, for example) can be wholly or selectively stress-relieved. If the furnace method is used, the entire piece is of course subjected to the heat; selective relieving is impossible. However, if a liquid salt bath or induction heating is used, the piece can be given overall relief or selective relief, whichever is desired.

Detailed information about stress-relieving is available through Bethlehem's technical staff. And remember that we can furnish the entire range of AISI standard alloy steels, as well as all carbon grades.

This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts about Alloy Steels." If you would like a free copy, please address your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

For more information, turn to Reader Service card, circle No. 335

WERNER

NEW EXTRUSION SPEEDS PRODUCTION OF WESTINGHOUSE FLUORESCENT FIXTURE

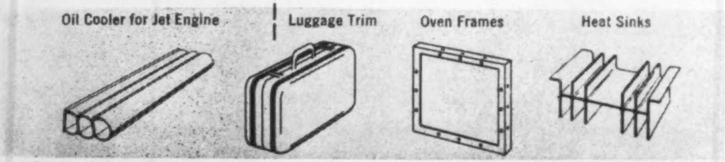
Werner's ability to produce a complex aluminum fixture to precise tolerances eliminated an assembly line bottleneck ... and simplified production of this new Westinghouse fluorescent fixture.

Lighter than the extrusion previously used, the new 73-inch aluminum housing is supplied cut to length, with end caps welded in place. Channels in the extrusion replace mounting holes and make the unit completely waterproof. Drilling, tapping and weatherproofing operations previously required to hold the reflector in place have been eliminated.

Werner aluminum extrusions may help you cut assembly costs and smooth out your production problems. Send us prints and specifications today. Werner engineers will be glad to work with you.

WERNER
ALUMINUM

☐ Please send me new handbook of WERNER ALUMINUM EXTRUSIONS
☐ Have salesman call
Name
Company
Address
City State



R. D. WERNER CO., INC. • 1316 OSGOOD ROAD • GREENVILLE, PA.

For more information, turn to Reader Service card, circle No. 465

through resistance of 16,000 psi at 200 F. Tests show it has three times greater cut-through resistance than any mica paper now available.

The new insulation is available in thicknesses of 8, 10, 12, 15, 20 and 25 mils. It is said to be compatible with most impregnating varnishes.

KEY NO. 620

Tungsten Alloy Ingots Sold in Large Sizes

Ingots containing 85% tungsten and 15% molybdenum are being made available in sizes up to 11 in. in dia by Climax Molybdenum Co., Div. of American Metal Climax, Inc., 1270 Avenue of the Americas New York 20.

R. E. Warriner, vice president of sales for Climax Molybdenum says: "To the best of our knowledge, no other full density alloy that will withstand temperatures over 5500 F is available commercially in such large sizes."

The ingots are supplied in three forms: as cast, machine turned, and heat treated to relieve casting stresses and facilitate machining.

The tungsten-molybdenum alloy is now being used in applications such as nozzles for missiles, and missile vanes and trajectory controls.

KEY NO. 621

Paint Adheres Well to Treated Aluminum

A new type of chemical treatment is said to greatly improve the adhesion of paints, lacquers, enamels, adhesives and other coatings to the surface of aluminum. Reason: a chemical reaction produces an organic surface on aluminum that has good compatibility with subsequently applied organic coatings.

The chemical treatment is called Chemlock 720 and is marketed by Hughson Chemical Co., Div. of Lord Mfg. Co., Erie, Pa.

According to the producer, Chemlok 720 is a cathodic treatment, preventing undercutting and blistering of paint films. The chemical treatment does not affect the base color of aluminum, and can be used with

What every designer should know about...

High nickel alloy cold wound springs for high temperature service

When made of suitable materials, particularly the age-hardenable alloys, cold-wound springs will provide somewhat higher mechanical properties and design stresses than those obtainable in hot-wound springs.

The heat treatments used for the nickel alloys, other than triple heat-treated Spring Temper Inconel "X"*, are such that distortion during aging or stress relieving is minimal. For triple heat-treated Inconel "X" springs it is necessary to mount springs on a heat-resisting mandrel to avoid distortion.

All of the high-nickel alloy springs retain outstanding spring characteristics at sub-zero temperatures down to –320° F or lower. Some increase is imparted to tensile and shear properties with no significant or adverse effect on elongation or impact properties.

The nickel-copper alloy "K" Monel* and the nickel-chromium alloys Inconel* and Inconel "X" are non-magnetic and the cold work resulting from cold drawing to spring temper or cold winding have no adverse effect on their low permeability.

The nickel-magnesium alloy "Permanickel"* has the highest electrical conductivity of all of these high-nickel alloys and as a result has found useful application for springs of limited current-carrying capacity.

Grain coarsen annealing of Spring Temper Inconel and No. 1 Temper Inconel "X" has been found to significantly improve resistance to relaxation at elevated temperatures.

One of the outstanding characteristics of Inconel and Inconel "X" is their resistance to relaxation at elevated temperatures, at design stresses, corrected for curvature, that will permit useful designs without consuming excess space.

A useful guide for selection of materials for elevated-temperature service is shown below.

GUIDE FOR USE OF NICKEL ALLOY COLD WOUND SPRINGS[1]

Alloy	Temper	Heat Treatment[3]	Service Temp-°F	Stress; 1000 psi[4]
Monel* Ni-Cu	Spring	Str. Rel.	Up to 450	60-40
"K" Monel* Ni-Cu	Spring	Aged	Up to 500	65-50
Duranickel* Ni-Al	Spring	Aged	Up to 600	70-60
Permanickel* Ni-Mg	Spring	Aged	Up to 600	70-60
Inconel* Ni-Cr	Spring	[2]Str. Rel.	Up to 750	75-60
Inconel "X"* Ni-Cr	Spring	Aged	Up to 700	100-85
Inconel "X"* Ni-Cr	No. 1	[2]Aged	Up to 1000	70-45
Inconel "X"* Ni-Cr	Spring	Triple H.T.	900 to 1200	55-30

1. Wire sizes up to 7/16 to ¾ diam., depending on material and spring index.

2. Grain coarsen annealed prior to final cold draw.

3. Will vary depending on alloy, temper and end use — consult revised Technical Bulletin T-35.

4. For elevated-temperature service, lower stresses applicable to higher temperatures — consult T-35.

Inconel and Inconel "X" alloys have outstanding resistance to high purity waters containing chlorides, to hot fatty acids and most neutral and alkaline salt solutions. The alloys remain bright indoors indefinitely.

In many cases Inconel and Inconel "X" offer cost advantages, both hot and cold wound, over high alloy steels for springs intended or elevated-temperature service.

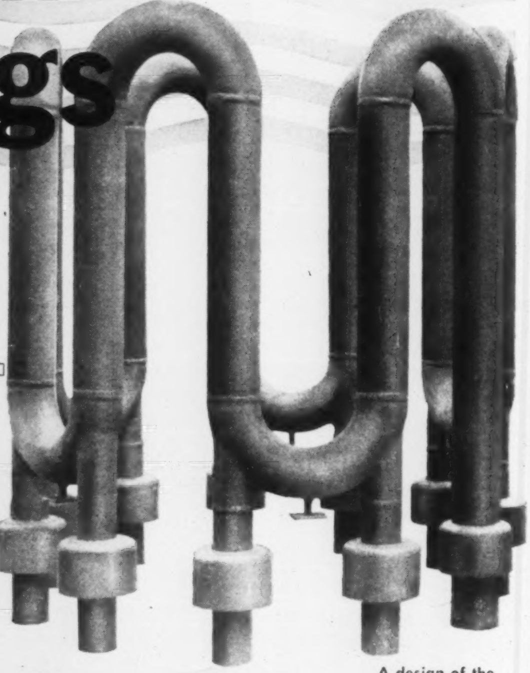
Helpful New Technical Bulletin T-35, "High Nickel Alloy Helical Springs" gives newly-developed information on test methods for relaxation; relaxation data and recommended stresses; effects of grain coarsen annealing; triple heated Spring-Temper Inconel "X" for service up to 1200° F; and hot forming practices. Write today for newly-revised Technical Bulletin T-35.

*Inco trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17, West Virginia

INCO ALLOY PRODUCTS
TRADE MARK

For more information, turn to Reader Service card, circle No. 389



when things are HOT... call on Duraloy

A design of the A. F. Holden Co., Detroit, Mich.

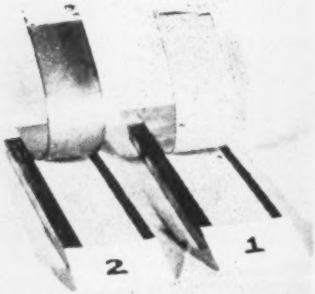
Castings that Keep their Load-Carrying Strength at High Temperatures

This "immersion type radiant heater" is typical of the high reliability castings turned out by DURALOY. Centrifugally cast tubes with *UNIFORM* wall thickness...for longest service life. Static cast collars and shell molded bends...typical of DURALOY versatility.

For your high alloy casting requirements check with DURALOY... our long experience, ultra-modern foundry and up-to-the-minute test equipment will be helpful in solving your problems. For more information ask for Bulletin No. 3150 G.

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

For more information, turn to Reader Service card, circle No. 358



Peel test results: *No. 1 is a piece of aluminum treated with Chemlock 720. Paint adheres firmly, failing cohesively in paint layer. No. 2 is an improperly treated piece of aluminum in which the paint peels off, leaving a bare strip.*

all types of paints and clear coatings. The treatment is adaptable to batch or continuous processing with either spray or immersion equipment.

Tests by Hughson show that adhesion obtained with the product is stronger than the applied coating, i.e., the paint film fails cohesively rather than by stripping off an aluminum specimen (see accompanying photo). KEY NO. 622

Lightweight Locknut Rated at 145,000 Psi

Improved performance and reliability in high temperature applications are provided by a new self-locking nut now available from Standard Pressed Steel Co., Jenkintown, Pa.

Locknut exceeds aerospace industry's standard

The company's locknut, called FN 1014, exceeds the tensile strength, maximum usage temperature, magnetic permeability and locking torque requirements of the aerospace industry's NAS 1291C nut standard. In addition, it is said to be the lightest-weight locknut available for its rated strength and temperature.

In comparison with minimum NAS 1291C requirements, the new nut is rated at 145,000 psi tensile strength

Stainless Steel
ATLAS

Out of this world . . .

MicroRold

MOON STEEL

Because stainless steel has helped to bring man's conquest of the heavens ever nearer, it has rightfully earned a new space-age name —MOON STEEL.

Since 1955, Washington Steel has been the exclusive supplier of light gage stainless steel sheet for the outer covering of the Atlas missile. The reason is simple: Washington Steel pioneered in the art of rolling stainless steel to uniform gages and has been able to meet the exacting specifications set up by space engineers for this momentous undertaking.

This is why MicroRold* stainless is truly out of this world!

WASHINGTON STEEL CORPORATION
Washington, Pa.

*REG T M

For more information, turn to Reader Service card, circle No. 393

IMPERVIOUS ALUMINA OR MULLITE...

CERAMIC INSULATING TUBING

FOR TEMPERATURES TO 3600 °F!

Sizes .020 and larger! Lengths to 60", depending on diameter and body specification! Rods also available!

Write for information today!

McDANEL Industrial CERAMICS

McDANEL
REFRACTORY PORCELAIN COMPANY
BEAVER FALLS • PENNSYLVANIA

For more information, turn to Reader Service card, circle No. 399

rather than 125,000 psi. Temperature limit is 1000 F rather than 800 F. Corrosion resistance is rated as excellent at temperatures up to 1000 F.

The locknut is forged from A-286 alloy and is silver plated to AMS 2410 standards.

Alternate electrical series

An alternate series, designated FN 1014M, is finished with a molybdenum disulfide dry film lubricant instead of the silver plate. The series is especially intended for electronic and other electrical applications where silver plating is not desired but low magnetic permeability is required. **KEY NO. 623**

Nine New Epoxies for Casting, Impregnating

Nine new epoxy resins have been introduced recently for a variety of applications including casting, encapsulating and impregnating.

1. Three flexible resins

Three flexible epoxy resins, called X-2673.2, X-2673.6 and X-2674, are now available from Dow Chemical Co., Midland, Mich. They are designed to give increased flexibility and toughness to conventional epoxy systems.

The materials are described as light colored, low viscosity fluids that can be blended with common liquid and solid epoxies, and with Dow's epoxy novolac DEN 438 (see M/DE, Jan. '60, p. 9). According to Dow, flexure strength of conventional epoxy resin systems can be increased 25 to 40% by using the new resins. But the company says use of the flexible resins affects other properties; namely, water, chemical and solvent resistance, and heat distortion.

The new resins are expected to find use in castings, laminates, adhesives and coatings. **KEY NO. 624**

2. Casting resins

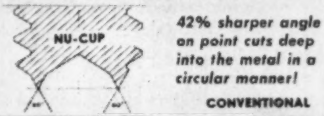
Emerson & Cuming, Inc., Canton, Mass. has introduced a fire retardant epoxy casting resin that can be cured at room temperature. The material is said to have excellent adhesion to metals, plastics and ceramics. The material, called Stycast 1231, remains stable over the tem-

✓ check these cost-cutting NEW IDEAS from SETKO

then check the coupon below for full information and free test samples

IDEA #1

"NU-CUP® POINT GRIPS THINWALL TUBING BETTER THAN ALL OTHERS TESTED!"



42% sharper angle on point cuts deep into the metal in a circular manner!

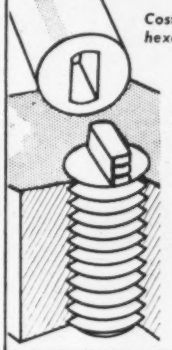
An independent manufacturer tested all types of points to find the one that would hold best . . . and perform most dependably. He chose NU-CUP. Could you use this idea? Check No. 1. (Name of Mfr. on request.)

Set Screw & Mfg. Co.

IDEA #2

THIS COST-CUTTER TAKES 50% MORE TORQUE BECAUSE OF SLABBED HEAD CONSTRUCTION!

Costs less than comparable hexagon head set screws.

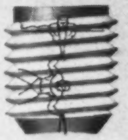


If you are having trouble with stripped heads or insufficient holding power, chances are the Setko Slabbed Head Set Screws are just the idea you need . . . Available in all points and metals. Check No. 2!

Set Screw & Mfg. Co.

IDEA #3

IS VIBRATION CAUSING LOOSE SET SCREWS ON YOUR PRODUCTS? . . . ELIMINATE THIS PROBLEM WITH ZIP-GRIP®!



Slight variation of thread causes locking action on mating surface!

Proven as an outstanding principle in many products, Zip-Grip has found particular acceptance wherever the stress of movement or vibration occur. Makes an outstanding adjusting screw . . . Can be reapplied many times . . . Got an idea? Check No. 3.

Set Screw & Mfg. Co.

IDEA #4

TINY SCREWS DO BIG HOLDING JOB . . . THEY'RE CALLED "MINI-MITE"

You'll find them perfectly-produced counterparts to their big brothers!

If miniaturization is one of the fields that you're interested in, then you'll see many good ideas in the perfectly-produced, money saving selection of Mini-Mites . . . Why pay for Specials when these can keep your costs at a minimum . . . Get the idea? Check No. 4.

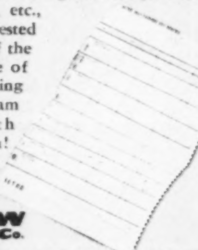
Set Screw & Mfg. Co.

IDEA #5

NEW SELF-LOCKING SET SCREW SELECTOR CHART LISTS OVER 1,001 COMBINATIONS.

Helps you determine available combinations best for your particular application!

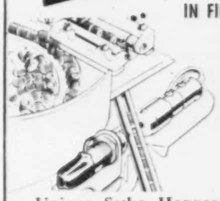
Here is another Setko first . . . A complete listing of locking actions, points, metals, drives, etc., including suggested applications of the complete line of Setko self-locking screws . . . It's jam packed with ideas for you! Check No. 5.



Set Screw & Mfg. Co.

IDEA #6

"SETKO HOPPER FEEDER SAVED US $42,000 IN FIRST YEAR."



Here's the first truly Automated method of hopper feeding Headless Set Screws.

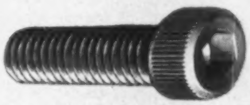
Unique Setko Hopper Feeder design orients headless Set Screws then feeds them to a driving device . . . Savings like the one shown above are but one of the advantages (name of mfr. on request) . . . Product quality is consistent, etc. This cost-cutting idea is one you can't miss! Check No. 6.

Set Screw & Mfg. Co.

IDEA #7

NOW YOU CAN GET COLD FORGED "PERFECT HOLE" CAP SCREWS IN THE NEW '60 SERIES . . .

and in STAINLESS STEEL, TOO!



If you're a user of Cap Screws you'll want to examine these yourself . . . We know you'll get our idea of trying to produce a perfect product consistently . . . We're sure you'll appreciate their performance once you've tried them . . . Would you like test samples? We'll be glad to send them! Check No. 7 and indicate sizes, etc.

Set Screw & Mfg. Co.

IDEA #8

THERE'S A BARREL-FULL OF IDEAS IN THE NEW 28-PAGE SETKO CATALOG #23.

SETKO
SOCKET SCREW PRODUCTS

The complete line of cost-cutting SETKO Socket Screw Products is at your fingertips.

You'll want this compact catalog for your personal use . . . And you'll particularly like the easy to read manner in which it has been prepared. Want a copy? Check No. 8.

Set Screw & Mfg. Co.

Set Screw & Mfg. Co.

149 MAIN STREET, BARTLETT, ILLINOIS

Please send me Idea information on items checked below. (If FREE samples are wanted of any of these products, send your specifications).

- ☐ 1. Nu-Cup
- ☐ 2. Slabbed Head
- ☐ 3. Zip-Grip
- ☐ 4. Mini-Mite
- ☐ 5. Self-Locking Selector Chart
- ☐ 6. Hopper Feeder
- ☐ 7. Cap Screw
- ☐ 8. Catalog

NAME____________________

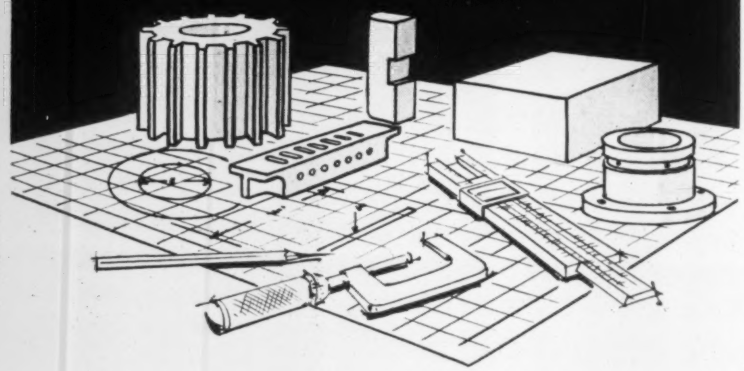
ADDRESS____________________

CITY__________ ZONE_____ STATE______

For more information, turn to Reader Service card, circle No. 443

whatever your product specifications...

ALL MATERIALS ARE NOT CREATED EQUAL



EXAMPLE: The Unique Properties Of Richardson Laminated INSUROK®

More and more Design Engineers are recognizing the superiority of Richardson laminates over other materials in a great many product applications. Specifically, here's why it would be profitable for you to examine and weigh the advantages of INSUROK.

Laminated and fabricated INSUROK parts assure top performance because of their unique combination of desirable plastic properties. INSUROK is strong and durable, highly dielectric, chemically-inactive, non-corrosive, heat and moisture-resistant. Weight . . . half as much as aluminum. It allows new design flexibility and has good machining qualities. Usually, no additional protective or decorative finish is needed. And, new grades are constantly being developed for new, challenging design applications.

Here at Richardson, we manufacture . . . and fabricate a complete line of laminated grades. Our complete fabricating service, from plants in Melrose Park, Illinois and New Brunswick, New Jersey, is your best guarantee of getting trouble-free, uniform parts. Richardson also custom molds a wide range of parts for consumer and industrial products.

Investigate the unequaled INSUROK advantages. Call your nearest Richardson Branch Office, or write direct.

THE RICHARDSON COMPANY

FOUNDED IN 1858

2782 LAKE STREET, MELROSE PARK, ILLINOIS
Sales offices in principal cities

Laminated
Fabricated
and
Molded
Plastics

For more information, turn to Reader Service card, circle No. 433

perature range —100 to 350 F.

KEY NO. 625

An improved, crystal-clear epoxy casting resin, called Maraglas No. 655, produced by Marblette Corp., Long Island City, N. Y., is said to have higher impact strength, greater resiliency and faster cure than the previously available resin. The cured product provides 90% light transmission. The resin is used for making bubble-free castings, prototypes, lighting fixtures, piping and decorative consumer items.

KEY NO. 626

Metal-Cast No. 405 AP is a general-purpose, 100% solids, filled epoxy casting resin recently introduced by Mereco Products Div. of Metachem Resins Corp., 530 Wellington Ave., Cranston 10, R. I. The developer says the material is suitable for use over the temperature range —75 to 390 F.

Another epoxy from Metachem Resins (address above) is Metal-Cast No. 441 which is a two-part, 100% solids epoxy casting compound. It is recommended for sealing, potting and encapsulating large items such as coils, resistors, transformers and other electronic parts. Its main feature is its adjustable flexibility, i.e., the cured material can be varied from a semi-rigid hard casting to a rubbery, flexible sealant.

KEY NO. 627

3. Impregnating resins

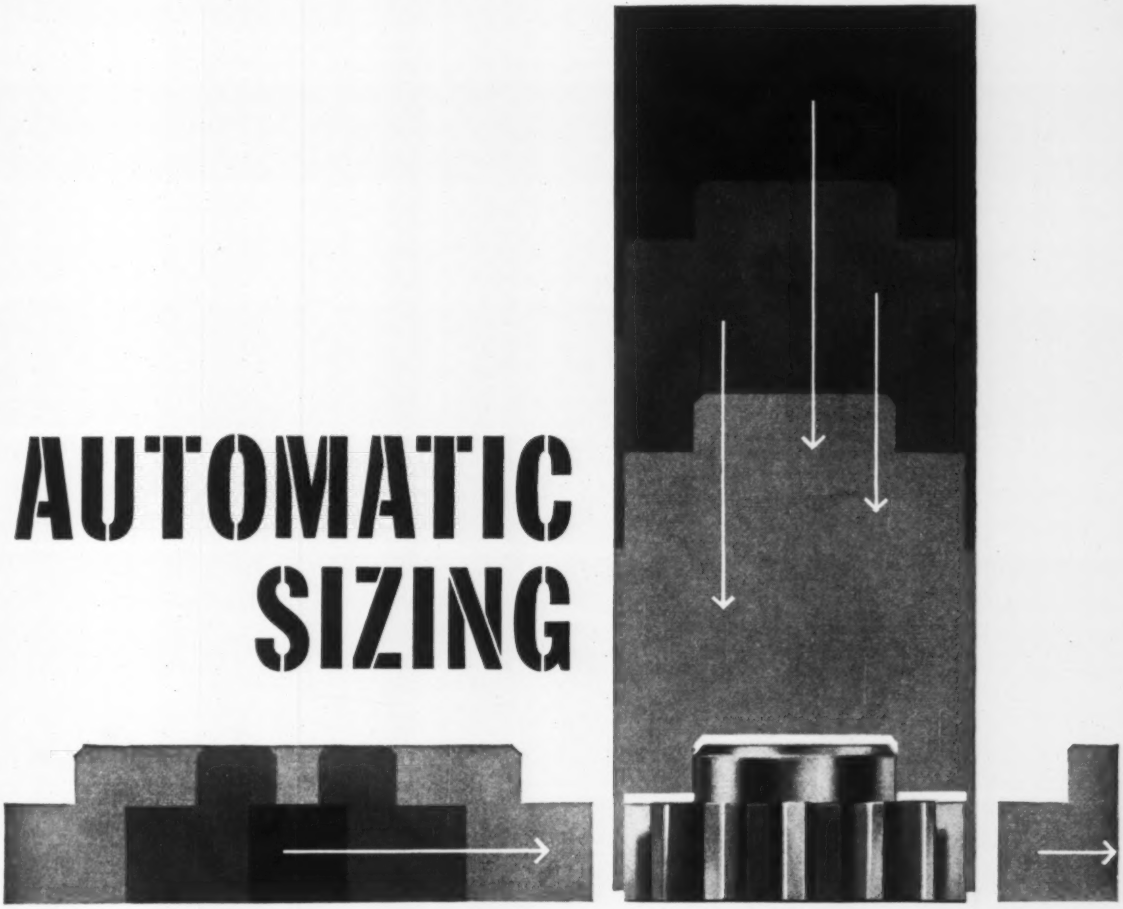
Epocast H-1338 is the name given to a new impregnating and encapsulating material supplied by Furane Plastics Inc., 4516 Brazil St., Los Angles 39. The material contains epoxy resins and coal tar derivatives. It is designed as an electrical insulation for transformers, terminal boards and other electrical parts.

KEY NO. 628

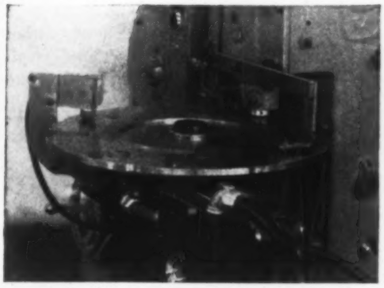
A one-part, nontoxic epoxy powder is expected to be used for encapsulating, sealing, embedding, impregnating and potting of semiconductors, modules and other electronic

WATCH FOR 'SELECTOR'—The fourth edition of M/DE's *Materials Selector* —revised, expanded and updated—will be published the middle of next month. The special issue is included in the M/DE subscription.

AUTOMATIC SIZING



speeds production of powder metal parts



The photo illustrates a modified Stokes compacting press, Model T-4, equipped with a special holding and feeding fixture for automatic sizing. This type of rotating fixture has proved highly successful in sizing small, complex parts.

Stokes brings new thinking, new designs to high-speed sizing of powder metal parts. With speed, accuracy, and minimum tool wear as design objectives, Stokes has modified many of its standard compacting presses for automatic high-speed sizing. The Stokes presses now in service are sizing a wide variety of powder metal shapes at high production speeds . . . and they are easily converted to operate either as sizing or compacting presses.

For special applications, Stokes offers such production-oriented design considerations as automatic feeders, orientation and inspection devices, and other innovations. It is this kind of advanced thinking that can keep you ahead of rising production costs . . . can help you plan for your future needs.

Consult Stokes Engineering Advisory Service on your specific powder metal application. You'll get professional assistance in designing parts, punches and dies, or complete production facilities. Technical information on the complete Stokes line of compacting presses is available on request.

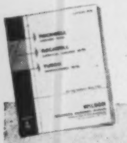
STOKES

POWDER METAL PRESS DIVISION • **F. J. STOKES CORPORATION** • 5500 TABOR ROAD, PHILADELPHIA 20, PA.

For more information, turn to Reader Service card, circle No. 449

For almost every hardness testing requirement
There's a Wilson "Rockwell" instrument to do the job

Wilson "Rockwell" Hardness Testers can help make your products better, stronger, longer lasting. They give reliable results on the production line, in laboratories, in tool rooms, and in inspection departments. They're as easy to use as a center punch, as durable as a machine tool, as sensitive and accurate as a precision balance. That's why Wilson "Rockwell" is recognized as the world's standard of hardness testing accuracy.

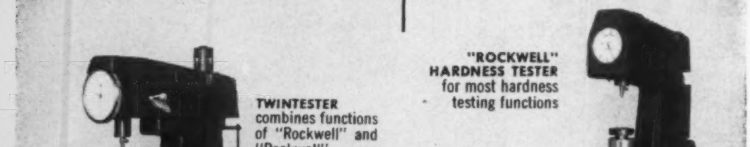


Write for Catalog RT-58. It gives complete details on the full line of Wilson hardness testing equipment.

Wilson "Brale" Diamond Penetrators give Perfect Readings

A perfect diamond penetrator is essential to accurate testing. Only flawless diamonds are used with Wilson "Brale" penetrators. Each diamond is cut to an exact shape. Microscopic inspection and a comparator check of each diamond—one by one—assure you of accurate hardness testing every time.

See us at the National Metals Exposition—Booth 1330


TWINTESTER combines functions of "Rockwell" and "Rockwell" Superficial Testers
"ROCKWELL" HARDNESS TESTER for most hardness testing functions
"ROCKWELL" SUPERFICIAL TESTER for extremely shallow indentations
TUKON for precision micro and macro testing
AUTOMATIC—semi and fully automatic models for automatically classifying tested pieces at rates to 1,000 pieces per hour

WILSON "ROCKWELL" HARDNESS TESTERS
ACCO

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-E Park Avenue, New York 17, New York

For more information, turn to Reader Service card, circle No. 391

and electrical devices. The product, available from Epoxy Products, 137 Coit St., Irvington, N. J., is said to have good resistance to moisture and chemicals, and good electrical properties. **KEY NO. 629**

Plastics Films Resist Moisture Absorption

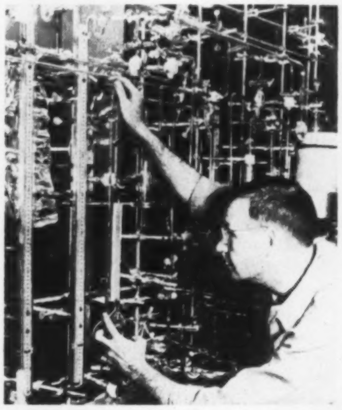
New fluorohalocarbon films featuring transparency and virtually zero moisture absorption are now available in pilot plant quantities from Allied Chemical Corp., General Chemical Div., 40 Rector St., New York.

The films, called Aclar, are expected to be used for packaging electronic and other delicate equipment, drugs and chemicals, according to the producer.

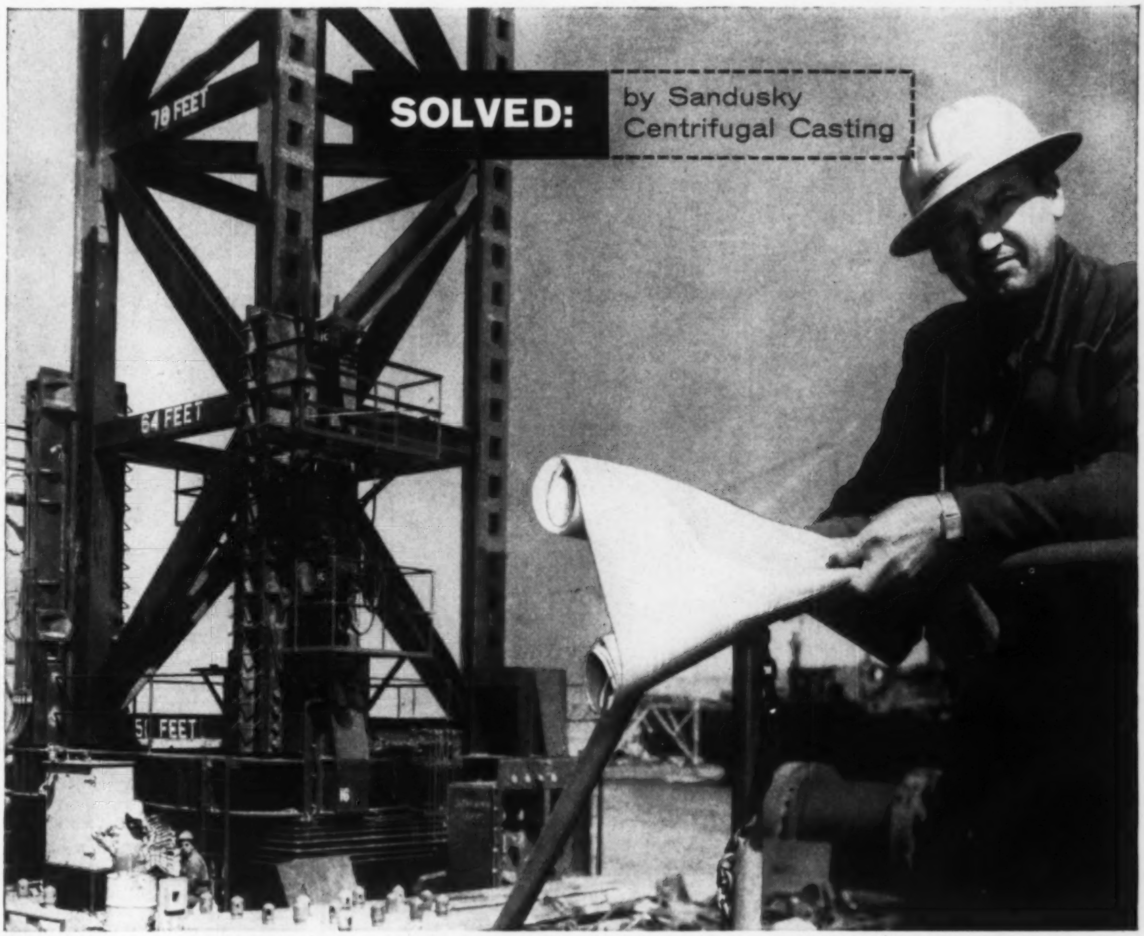
Better moisture barrier than other plastics films

F. J. French, president of Allied's General Chemical Div., says, "An outstanding characteristic of the films is their low moisture vapor transmission. For example, to get the moisture barrier benefits of Aclar type 33 film, a saran film would have to be over 100 times as thick, a polyethylene film over 400 times, and a polyester film over 700 times as thick."

The company says this extremely low moisture vapor transmission, plus transparency and good impact strength, permits the film to meet



***Permeability test** shows new plastics films have virtually zero moisture absorption.*


SOLVED: by Sandusky Centrifugal Casting
78 FEET
64 FEET
51 FEET

One of four 274 ft. high towers aboard the *George F. Ferris* showing method of installing hydraulic jacks built by Yuba Manufacturing Division, Yuba Consolidated Industries, Benicia, Calif. George Bauer, of Delong Corp., New York, is shown supervising construction while platform is being completed at Yuba's Richmond, Calif., plant.

YUBA gets quality-cost-delivery advantages by specifying 16 Sandusky cylinders

Sixteen 500-ton hydraulic jacks built by Yuba, for which Sandusky supplied the main cylindrical bodies, enable the new pipe-laying barge, *George F. Ferris,* to operate in waters 200 ft. deep!

This 5400-ton barge is equipped with four structural steel towers 274 ft. high. Four jacks on each of the towers provide the power to lower these steel "legs" to the ocean floor, raise the barge above the surface of the water, or retract the towers to render the barge navigable. The steel jack cylinders are Sandusky Centrifugal Castings, made to the requirements of ASME Code-approved SA-217, Section VIII, Unfired Pressure Vessels, to withstand operating pressures of 3000 psi. They were produced in 186" lengths, machined to 24" O.D. with 2" thick walls and sectioned into four pieces 43" long.

Yuba's selection of Sandusky Centrifugal Castings was based largely on three essential factors: QUALITY—meeting the exacting Code requirements . . COST—saving about half the cost of an alternate method of manufacture . . and DELIVERY—coming through on a tough time schedule by delivering all 16 cylinders within 21 working days!

When you need cylinders from 7" to 54" in O.D. and up to 33 feet long it will pay you to get in touch with us. Write for our latest booklet, *Your Solution To Cylindrical Problems* containing data on more than 70 ferrous and non-ferrous alloys.

SANDUSKY ® **CENTRIFUGAL CASTINGS**
FOUNDRY & MACHINE CO.

5902

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

For more information, turn to Reader Service Card, circle No. 473

SECTION D-D
A
G
G
Courtesy Scott Aviation Corp.

New Molded Profile Reveals Techniques for Better Rubber Specs

In the early stage of planning and design, it was questionable whether this face mask could be molded in rubber—in one piece—practically, yet economically . . . and here's why.

It calls for an ingeniously designed and machined mold to provide for facial contours, air inlets and outlets, undercuts, feathered edges, valve mounts, fastenings, etc.—one of the hardest-to-fill cavities ever encountered. Also, the rubber must be compounded to flow freely inside this complicated form and still maintain its knitting qualities. How was this accomplished?

While the mask was still in the design stage the customer realized the importance of consulting a rubber specialist. From this conference came an exchange of suggestions which led to a practical and functional design that permits molding these masks with unusual speed and economy. Here's the idea.

While a job is still on the drawing board consult with rubber specialists. Suggestions can often be made to eliminate high tooling costs or high priced compounds. End results give you better rubber parts, better performance and lowest cost. Regardless of how simple or complex your rubber needs may be call Continental—specialists since 1903.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
CR *engineered by* **CONTINENTAL**

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For more information, turn to Reader Service card, circle No. 346

requirements of military specification MIL-F-22191 for packaging applications.

Other characteristics of the films:

1. They retain flexibility and other useful properties over the temperature range -320 to 390 F.
2. They resist most corrosive acids and alkalis. **KEY NO. 630**

Inconel Added to Line of Nuclear Tubing

Inconel tubing has been added to a line of nuclear quality heat exchanger tubing now available from Superior Tube Co., Norristown, Pa. The Inconel tubing is said to be highly resistant to corrosive attack, even with oxygen and chlorine ions present in the water. Thus, it resists cracking under stress-corrosion conditions.

The nuclear quality tubing is drawn from carefully selected tube hollows with closely controlled chemical composition; cobalt content is held to 0.10% or less, assuring minimum radiation hazards.

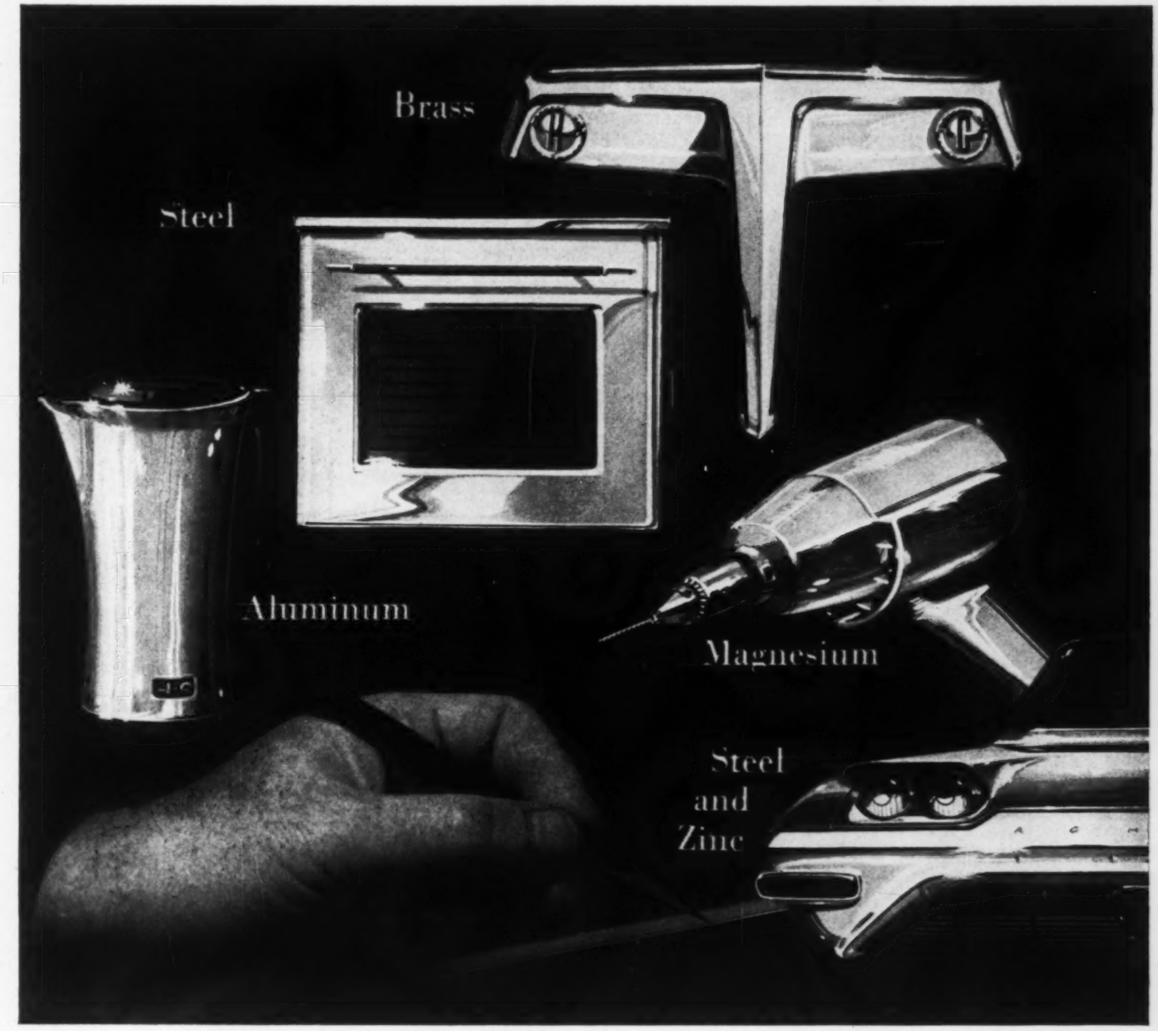
The Inconel heat exchanger tubing is furnished in sizes of 0.125 to ⅝ in. o.d. with wall thickness ranging from 0.0015 to 0.125 in. It is also supplied in sizes of ⅝ to 1⅛ in. o.d. with maximum wall thicknesses of 0.035 in. **KEY NO. 631**

Water Soluble Film Protects Brass Parts

A new water-base protective coating for use on brass and brass-plated steel parts has been introduced by Logo Div., Bee Chemical Co., 12933 S. Stony Island Ave., Chicago 33.

Parts are coated by dipping in a water soluble, noninflammable compound called Lacqua M-800. The producer says the clear coating resulting from the immersion treatment is identical in appearance to conventional lacquer and enamel films obtained with flammable organic solvent systems.

Parts coated with the compound can be soldered, and the coating can be removed by using commercial



Choose any basis metal you desire and give it

a lustrous, lasting finish of Nickel-Chrome Plating!

Nickel-Chrome Plating provides a practical way to combine the beauty and protection of Nickel and chromium with the special properties of other metals:

- formability of brass
- strength of steel
- extrudability of aluminum
- lightness of magnesium
- conductivity of copper
- design flexibility of zinc-base die castings

Today's adaptable Nickel-Chrome Plating gives you the freedom to use a wide variety of basis materials to achieve the most desirable combination of performance, fabricability *and* practical cost.

Select the basis material that proves most suitable. Nickel-Chrome Plating will give it lustrous, matching beauty with brilliant blue-white color. Beauty with outstanding durability, too.

That's because Nickel-Chrome Plating not only provides shining sales appeal, but also protects basis metals from rust and corrosion. Protects basis materials from nicks and scratches. Makes the lustrous beauty lasting beauty.

So with Nickel in ample supply as far into the future as any man can foresee, there's no better time than now to use Nickel-Chrome Plating to your product's best advantage. Whether you want smoothing action, blue-white brilliance or satin tones—together with long-lasting protection—there's a Nickel coating to fit your requirements.

For information on accelerated corrosion testing of plated coatings, just drop us a card for your copy of "CORROSION TESTING OF ELECTRO-DEPOSITED COATINGS."

The International Nickel Company, Inc.
67 Wall Street INCO New York 5, N.Y.

Inco Nickel

Nickel makes plating perform better longer

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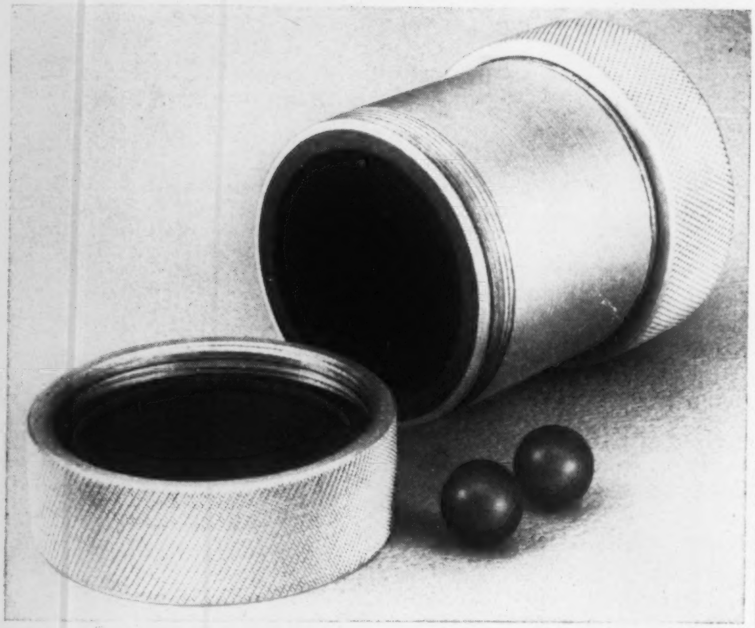

In this KENNAMETAL* lined container, some of the hardest materials known to man are reduced to powder

Tungsten metals, silicon carbides, asbestos fibers, blast furnace slag, copper shot, alumina beads . . . are all conquered in this grinding vial used in a laboratory size mill.

Such materials pack, thereby preventing thorough grinding. At the same time, they peen out, smear and erode the surfaces of the usual mortar and pestle or ordinary ball mill. But the Spex Mixer Mill, using Kennametal Balls in a Kennametal-lined cylinder, can grind a lab size sample down to −300 mesh or finer in just 10 minutes. Grinding is uniform, with hardly a trace of contamination.

The hardness of Kennametal (up to 94.7 Rockwell A) makes the difference. Hardness is but one of the many exceptional properties of Kennametal. When you need a material with great rigidity, resistance to heat, corrosion, abrasion, erosion, and compression . . . chances are Kennametal may be the answer.

To help solve an immediate problem, or a future need . . . we'd like to send you Booklet B-111B "Properties of Kennametal" and our new Booklet B-666, "Proven Uses of Kennametal and Kentanium."* Write Dept. MDE, KENNAMETAL INC., Latrobe, Pennsylvania.

*Kennametal is the registered trademark of a series of hard carbide alloys of tungsten, tungsten-titanium, and tantalum. Kentanium is the registered trademark for one of the series that has special advantages for applications requiring a lighter weight material or maximum resistance to temperature extremes. 33537

INDUSTRY AND
KENNAMETAL
...Partners in Progress

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alkaline stripping compounds.

Properties of coating

Salt spray resistance—Tests showed that brass-plated steel specimens coated with Lacqua M-800 withstood 96-hr exposure to salt spray with no edge creep from the side and no spotting on the face of the specimens.

Moisture resistance—Coated specimens withstood 1400-hr exposure to 100% RH at 110 F with no visible damage.

Impact resistance—Coated specimens withstood 30 in-lb reverse impact tests with no fractures.

KEY NO. 632

Modified Nylon Has Improved Properties

Better uniformity of all properties regardless of section size, improved molding properties, and minimum moisture distortion are said to be the chief characteristics of a modified, type 6 nylon molding resin.

Key to the resin's improved properties is its fine crystalline structure: it has a maximum spherulite size of 2.1 μ at 400X magnification, compared to 17 to 26 μ for unmodified type 6 nylon.

The fine crystalline resin is available from Foster Grant Co., Inc., 289 N. Main St., Leominster, Mass. It is called Fosta nylon modified type 6. **KEY NO. 633**

Printed Circuits Withstand 1800 F

A newly developed ceramic circuit board with a printed metal circuit can be subjected to temperatures up to 1800 F without failure, according to Mitronics Inc., 1290 Central Ave., Hillside, N. J. The printed circuit board is also said to withstand high humidity and corrosive environments.

The circuit board is 96% alumina on which is screened a metal printed circuit composed of molybdenum and manganese. The metal circuit is protected with an electroplated coating of nickel or copper which serves as a base for hard or soft solders.

The ceramic circuit boards can be

NAME YOUR STAINLESS SHAPE!

The design and manufacture of quality stainless steel castings is a specialized job . . . *and Dodge specializes in it!*

There is practically no limit to the variety of shapes we can turn out to meet your simple or intricate specifications precisely . . . economically.

Perhaps one or more **DS** castings shown here will help spark an idea of how Dodge can be of assistance for *your* stainless steel casting needs. A blueprint or sketch with operational details will bring complete information, without obligation.

DODGE STEEL COMPANY

6501 State Road
Philadelphia 35, Pa.

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DS
DODGE PRODUCTS

THE MOST IMPORTANT ALLOY IN A STAINLESS STEEL CASTING IS QUALITY

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From New York to Los Angeles and back—3½ times!

annual production capacity of ultra-thin metal strip now totals 96 million feet

Production capacity of ultra-thin metal strip and foil at Precision Metals Division of Hamilton Watch Company today is unmatched by any other plant in the world. This unique metals processing plant is now capable of an estimated annual volume of more than 18,000 miles of ⅛″ x .000125″ strip.

thicknesses from .100" to .0001" Hamilton precision strip and foil is available in virtually any alloy cold rolled in a thickness range from .100″ to ultra-thin .0001″ in widths up to 10″. Precise control of metallurgical and physical properties is maintained at all times.

comprehensive metallurgical facilities The Precision Metals Division is a completely integrated metals processing plant with facilities available for development and production. Special alloys to your own specifications can also be furnished in the form you require. For information write today for Facilities Booklet DE-10 and Technical Data Sheets on such metals as Stainless Steel, Magnetic Alloys, Alfenol, Havar and Elinvar Extra.

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HAMILTON
WATCH COMPANY / Precision Metals Division
Lancaster, Pennsylvania

Representatives COREY STEEL COMPANY • Chicago, Illinois
FAGERSTA STEELS PACIFIC, INC • Los Angeles, California

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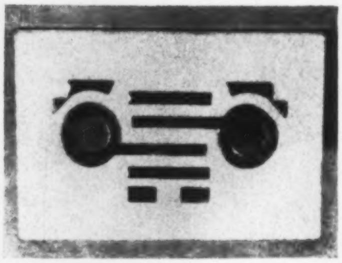


***Ceramic circuit board** with molybdenum-manganese printed circuit.*

made in sizes up to 18 sq in. Pattern configurations can be screened on the ceramic boards to tolerances of ±0.005 in. **KEY NO. 634**

Coating Adheres to Uncleaned Aluminum

A new synthetic baking enamel can be applied directly to uncleaned and untreated aluminum. It was developed by Cosden Paint Co., Beverly, N. J. Available clear or pigmented, the coating is particularly suited for use on foil packaging, gift wrapping and containers.

The high-gloss coating is said to form a tough, abrasion resistant film which will not scratch or rub off. It can be applied by spray or roller coating methods. Baking schedules vary from 10 sec at 500 F to 15 min at 300 F.

The developer says the coating has excellent coverage because of its high solids content. For example, 1 gal of the coating will cover over 3000 sq ft of 0.0002-in. thick aluminum foil. **KEY NO. 635**

Adhesives for Bonding Rubber, Plastics, Metals

New adhesives now on the market include: 1) a water-base adhesive for dry bonding supported and unsupported materials; 2) a rubber-base adhesive for bonding urethane foams; 3) a translucent adhesive that permits delayed assembly of various products; 4) a fast drying adhesive for bonding rubber and plastics foams; and 5) a urethane

where can you use WATER SOLUBLE coatings?

A NEW FAMILY OF NON-FLAMMABLE COATINGS THAT BECOME WATER INSOLUBLE ON APPLICATION

Protective clear films for metal protection—some superior even to the high bake enamels or lacquers—can be produced by use of the new LACQUA coatings developed by BEE CHEMICAL COMPANY.

APPLICATIONS UNLIMITED

LACQUA has aroused high interest in many industries and is in current use in the electroplating field (see right). It is also being evaluated in the *steel processing, automotive, electronic, textile*, and *paper fields*, to name a few.

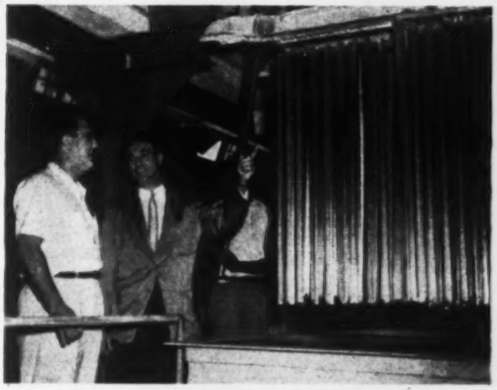
Its use as a primer to replace either the flammable coatings or emulsion coatings for auto underframes, structural and sheet steel, and as a coating for aluminum foil are under study.

APPLICATION METHODS

Although primarily developed for dipping, tests indicate the LACQUA products may also be applied by airless spraying or by roller coating.

COOPERATIVE DEVELOPMENT

Our Field Product Development Department welcomes the opportunity of cooperating with you to determine the merits of one of this family of highly unique coatings for your application.



ADOLPH PLATING INSTALLS LACQUA M-801 INTO PLATING LINE

Adolph Plating, Inc., Chicago, one of the largest job plating firms in the country, has installed LACQUA M-801 into its regular plating line. Shown in photo above, Adolph Plating's sales manager, Ray Giesel (right) discusses the system's advantages with production manager, Richard Giesel. The coated parts shown are zinc-plated tubing dipped in LACQUA M-801. They will be used in the manufacture of home movie screens.

Adolph plating specializes in cadmium, zinc and copper plating and is now offering the LACQUA protective coating to its customers in the automotive, electronic and metal fabricating industries.

Bee chemists check results of an independent laboratory test conducted by Accurate Engineering Laboratories, Chicago. Brass-plated panels coated with LACQUA M-800 withstood 96 hours salt spray exposure, with only slight edge creep. Panel at left, a leading water soluble lacquer, showed complete failure after 48 hours exposure.

☐ I want to evaluate the LACQUA coatings for application on: ____________

____

We manufacture: ____________

Type of protective coating now used: ____________

____

☐ Enter my order for a trial quantity of LACQUA at $5.60/gallon for:

☐ 1 gallon ☐ 5 gallons ☐ 25 gallons

of the LACQUA product best suited for the above application.

Name ____________ *Position* ____________

Company ____________

Address ____________

City ____________ *Zone* ______ *State* ______

BEE CHEMICAL COMPANY
LOGO DIVISION
2700 East 170th Street, Lansing, Illinois • Phone GRanite 4-7000
GARDENA, CALIFORNIA • HARTFORD, CONNECTICUT

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Use this **designers' check-list** for

MORGANITE
FINE CARBON
GRAPHITES

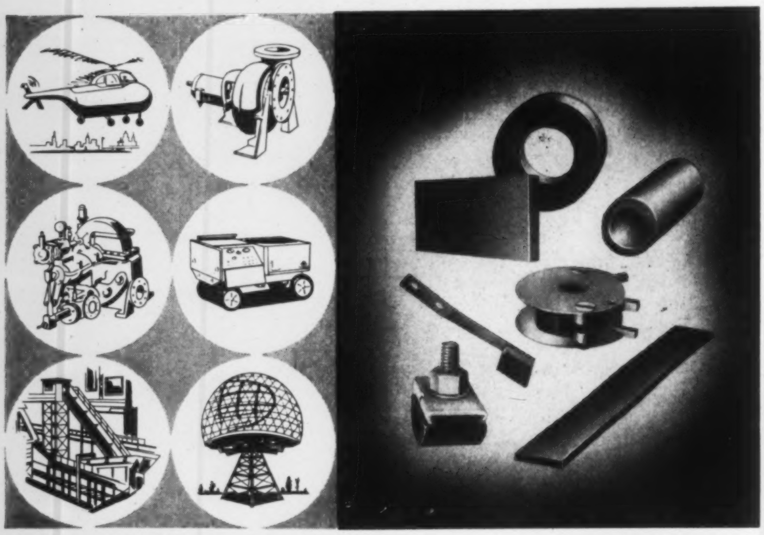
Performance-proven Grades to Solve
a Wide Range of Design Problems

CY SERIES – Plain carbon graphite. Excellent for bearings, vanes, valves and other mechanical components.

MY SERIES – Metallized carbon graphite. Provides extra-long life in difficult applications wherein operating conditions are severe.

PY SERIES – Non-metallized carbon graphite. Specially treated for use in high pressure seals.

EY SERIES – Provides exceptionally high-reliability in the presence of high temperatures (to 1000° F).



Self-lubricating Morganite possesses many different advantages capable of solving a wide range of operating problems. These dependable materials are specified for a broad list of components ranging from bearings in sealed mechanisms to electrical contacts operating in extremes of temperature.

Call or write for literature or recommendations on specific applications. Morganite sales engineers will be happy to explain the advantages of Morganite for use on original equipment or as replacement parts in your maintenance projects.

Morganite ...FOR OVER HALF A CENTURY
INCORPORATED
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In Canada: Morganite Canada Ltd., Toronto

Manufacturers of Fine Carbon Graphite Products including Mechanical Carbons, Motor and Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts...Distributors of 99.7% Pure Al_2O_3 Tubes, Crucibles and Crusilite Heating Elements

For more information, turn to Reader Service card, circle No. 406

adhesive for bonding rubber to metal.

1. Water-base adhesive

Vinylstix Heat Seal is the name given to a new, water-base adhesive designed for dry bonding supported and unsupported plastics, cotton, wool, leather, paper, cellulose acetate and other materials. A strong bond forms between materials coated with the adhesive when heat is applied.

The new product is marketed by Adhesive Products Corp., 1660 Boone Ave., New York 60. **KEY NO. 636**

2. Rubber-base adhesive

A clear, rubber-base adhesive has been formulated especially for bonding urethane foams or rubber foams to themselves. Called Rez-N-Glue No. 301, it is available from Schwartz Chemical Co., Inc., 50-01 2nd St., Long Island City 1, N. Y. The fast drying adhesive is said to produce a translucent bond.

KEY NO. 637

3. Translucent adhesive

A translucent, amber colored adhesive that retains tackiness for several hours is said to permit delayed assembly of trim fabric, insulation and similar materials to metals and fiberboard. It is called Rez-N-Glue No. 164, and is available from Schwartz Chemical Co. (address above). Composition has not been revealed.

The producer says no unsightly residue results from use of the adhesive as is the case with red or black adhesives. Bonds are said to be tough and resistant to heat, cold and water. One gallon of the translucent adhesive will coat approximately 250 sq ft. **KEY NO. 638**

4. Fast drying adhesive

A fast drying adhesive for bonding foam rubber, urethane foam and vinyl foam to themselves and to leather, wood, fabrics and other porous materials has been developed by Rubba, Inc., 1015 E. 173rd St., New York 60.

Called Rubbafoam, the adhesive is said to leave an almost invisible glue line in bonded products. Its composition has not been disclosed.

KEY NO. 639

5. Urethane adhesive

A room-temperature-curing urethane adhesive for bonding rubber to metal is now available from Plastic Associates, 2900 S. Coast Blvd., Laguna Beach, Calif. The two-part

size is no problem!

ACIPCO CERAM-SPUN
steel tubing available
from 2.25″ to 50″ O.D. . . .
wall thicknesses from
.25″ to 8″. . . lengths
from 4′ to 20′
(Longer lengths can
be made by welding)

The bigger your tubular steel problem – the better we like it! Why? Because with all our modern facilities "under one roof," we are completely equipped to handle a variety of difficult jobs – expertly and economically! For expert consultation on centrifugally spun tube applications in your field . . . call on ACIPCO.

VERSATILE ACIPCO CENTRIFUGALLY SPUN STEEL TUBES

SIZE RANGES: Tubes are produced in lengths from 4′ to 20′; longer lengths are made by welding. O.D.'s from 2.25″ to 50″ — wall thicknesses from .25″ to 8″.

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steels, plain carbon steel and special non-standard analyses.

FINISHES: As cast, rough machined, or finish machined, including honing and grinding. Complete welding and machine shop facilities are available.

Write for FREE Illustrated Catalog.

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SPECIAL PRODUCTS
DIVISION OF **AMERICAN CAST IRON PIPE CO.**
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For more information, turn to Reader Service card, circle No. 325

BEARINGS & SEAL RINGS FOR 1200°F

When the heat is really "on" and ordinary graphite and even exotic metals fail, the new Stackpole 741 Graphite may well be your answer! Even surpassing Stackpole's famous 469 grade in oxidation resistance, Grade 741 paves the way for significant improvements in seals and bearings for jet engines and other high temperature applications.

Thanks to a new break-through in chemical processing, Stackpole Grade 741 operates reliably in the 1000° to 1200°F range and below. The material has a low coefficient of friction . . . exhibits very little wear even at maximum temperatures. And it retains graphite's inherently excellent self-lubricating properties.

741 High-Temperature Graphite is just one of numerous highly specialized carbon and graphite materials developed by Stackpole for difficult mechanical applications. To learn more about their economy and performance advantages, why not submit details of your applications to Stackpole for recommendation? STACKPOLE CARBON CO., St. Marys, Pa.

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GRAPHITE

CERAMAG® FERROMAGNETIC CORES • SLIDE & SNAP SWITCHES • VARIABLE COMPOSITION RESISTORS • FIXED COMPOSITION CAPACITORS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT • ELECTRICAL CONTACTS • GRAPHITE BEARINGS & SEAL RINGS • COLDITE 70+ FIXED COMPOSITION RESISTORS • AND HUNDREDS OF RELATED PRODUCTS

For more information, turn to Reader Service card, circle No. 447

adhesive, called PA-820, is suitable for such applications as attaching rubber feet to metal instrument cases, and installing flexible seals on cabinet doors. **KEY NO. 640**

Rubber-Epoxy Paints Are Solvent Resistant

A series of protective coatings with good chemical, solvent and abrasion resistance has been developed by Cosden Paint Co., Beverly, N. J. The coatings are mixtures of polysulfide liquid polymers and epoxy resins.

The developer says the liquid polysulfide polymers which form flexible, elastomeric films with good solvent and weathering resistance are blended with epoxy resins which provide hard, chemical resistant films that adhere to many types of materials.

Made in several formulations

The new coatings are supplied in several formulations ranging from solvent systems to 100% solids. Special systems are available for coating wet concrete, wood, and rusty steel. Most of the coatings cure over a wide temperature range, some as low as 40 F.

Potential uses include coatings for equipment exposed to corrosive chemicals, electrical insulating coatings, marine coatings, nonskid surfacing, electrical conducting coatings, and patching compounds.

KEY NO. 641

Oriented TFE Sheets Keep Their Shape

A new TFE sheet material is said to keep its shape better than conventional TFE sheets. Reason: the product undergoes an orienting process in which a sintered TFE sheet is further compacted by pressing in a hydraulic press. The process is said to substantially reduce both initial deformation and long-time creep of TFE sheet materials.

The developer, Cadillac Plastic & Chemical Co., 1511 2nd Ave., Detroit, says a big use for the oriented sheet material will be gaskets. Tests show that loadings on oriented TFE

Coming in November . . .

1961 MATERIALS SELECTOR

The year's biggest boon to those time-pressed engineers, designers, and other technical men who select and specify engineering materials, forms and finishes! This new MATERIALS SELECTOR is more than 70 pages bigger than last year's edition.

All editorial pages in the MATERIALS SELECTOR are in data sheet form to provide you with quick comparisons of properties and applications of hundreds of metals; nonmetallics; forms and shapes; and finishes and coatings. Keep the SELECTOR on your desk for ready reference. You'll find it a real time saver.

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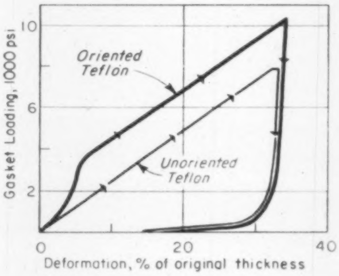
What's new IN MATERIALS



Compression and recovery *of oriented vs unoriented TFE at 73 F. Compression of gaskets was measured with a dial indicator at four points on platen of tester. Gasket size was 7½-in. i.d. by 8½-in. o.d. Oriented TFE gasket was 0.134 in. thick; unoriented gasket was 0.136 in. thick.*

gaskets can be increased by as much as 25% without increasing the percentage of deformation.

The sheet material is supplied in sizes up to 48 by 48 in., in thicknesses from 1/32 to 2 in.

KEY NO. 642

O-Ring Compounds Withstand Heat, Fuels

Two companies have recently developed new heat and fuel resistant rubber compounds for use in o-rings, and molded and extruded shapes.

1. Fluorosilicone compound

Stillman Rubber Co., 5811 Marilyn Ave., Culver City, Calif. is marketing a compound called TH-1047 that is based on fluorosilicone rubber.

The compound has a Shore A durometer hardness of 50 to 55, and good resistance to JP-4 jet fuel, Skydrol and other hydraulic fluids. The compound is said to maintain its physical characteristics over the temperature range —75 to over 400 F.

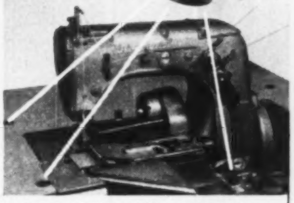
The company says o-rings and molded shapes made from the compound meet military specification MIL-R-25988. **KEY NO. 643**

2. Viton B compound

Haveg Industries, Inc., Taunton Div., 336 Weir St., Taunton, Mass. has developed a Viton B compound that is said to have good resistance

Wilbow

Bonded Rubber Parts Assure Durable Resilience



WILBOW Bonded Rubber Vibration Isolators contribute greatly to the smooth, quiet operation of Union Special Sewing Machines like this—for life!

The high-speed, precision operation of Union Special Industrial Sewing Machines calls for special vibration damping mountings. To be sure of the strength, service life and durable resilience required, Union Special designers have made WILBOW Bonded Rubber Vibration Isolators a structural standard.

WILBOW specializes in bonding natural, synthetic or silicone rubbers of all types to a wide range of metals, including stainless steel. The parts produced combine, permanently and reliably, the desirable properties of both rubber and metal. Let WILBOW engineers study your possible applications—or send for the WILBOW catalog and see the variety of bonded rubber parts available. Write today.

Wilbow

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Mfrs. of molded, punched, extruded and cut rubber goods. Specialists in producing rubber covered rolls, silicone rubber parts and bonding rubber to metal

For more information, turn to Reader Service card, circle No. 467

ACTUAL SIZE

ACTUAL SIZE

Conversion to NYLON-GEAR BY SMALL-LOT MOLDING PROCESS

SAVES 26¢ PER UNIT

This Zytel 101 Nylon Beveled Gear replaced a machined gear that formerly cost 59¢ each. After the initial tooling costs we die-molded it in one operation by our special injection process at 33¢ each.

COST ANALYSIS:

Tooling, set-up and first 100 pieces, including material and trimming $286.00

Additional 100 lots: $33.00

In addition to a cheaper piece price and equal wearing qualities, the Nylon Gear proved rustproof, noiseless, required no oiling and weighed less.

Let us quote on your Short-Run Plastic Moldings. We will gladly submit quotations without obligation.

DAYTON ROGERS
Manufacturing Company

MINNEAPOLIS 7X, MINNESOTA

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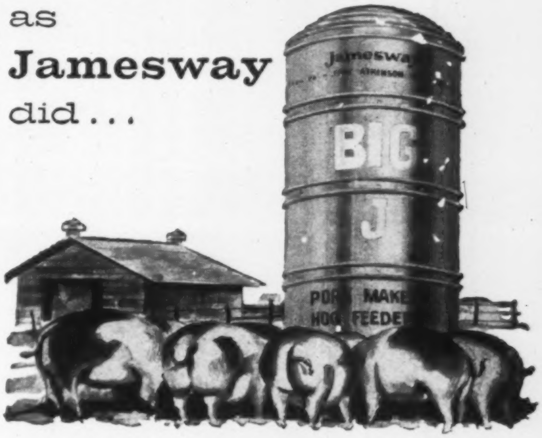
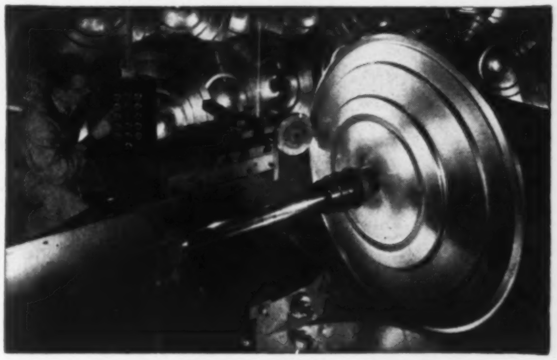
Don't Buy a Pig in a Poke! Try **Spincraft** as Jamesway did . . .



Spincraft designed and produced a rigid, lightweight, seamless hog feeder cover to replace an old high-cost, ugly riveted unit.
Result: Improved appearance, reduced cost.

Spincraft redesigned the feed spreader from a riveted, pie-cut piece to a seamless, precisely-sized cone.
Result: Rapid, effortless assembly; reduced cost.



You, too, may attain cost-reducing shortcuts and design improvements on your metalforming needs by calling upon Spincraft.

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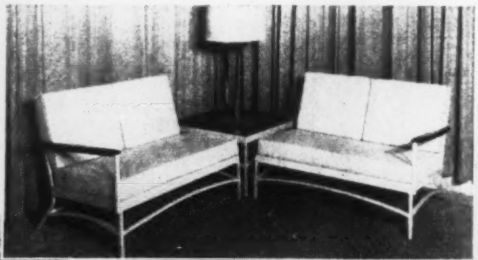
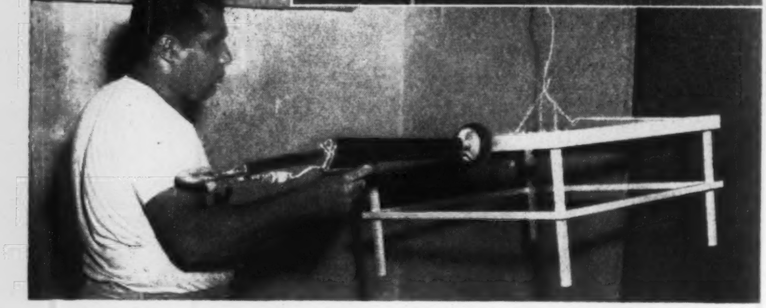




What Would

75% PAINT SAVINGS

Mean in YOUR Finishing Department?

Designed for the New Decade—Beautifully styled BAL HARBOUR line of aluminum furniture by AFCO was winner of the 1960 Apollo Award for pre-eminence in design. The uniform, high quality finish is applied electrostatically with the Ransburg No. 2 Process Hand Gun.

Faster . . . Cleaner . . . Cheaper—The "wrap-around" feature of the No. 2 Process Electrostatic Hand Gun paints all areas of this type of work from one side only, providing a 75% paint savings and a 700% increase in production volume over former air hand spray.

RANSBURG

Ransburg No. 2 Process Electrostatic Hand Guns are providing a 75% paint savings in the painting of beautiful AFCO aluminum furniture.

AFCO Aluminum Furniture Co., Inc., Miami, Fla., replaced hand spray with two Ransburg Electrostatic Hand Guns. Along with paint and labor savings, quality of the work was improved with greater uniformity. And, production volume was increased a healthy 700%! Formerly, they were painting approximately 100 items a day. NOW, with the faster, cleaner Electrostatic Hand Guns, they paint from 700 to 800 pieces per day. Electrostatic is faster because the "wrap-around" characteristic of Electro-Spray paints all areas of this type of work with a pass from one side only.

NO REASON WHY YOU CAN'T DO IT TOO

Write for information and literature about this revolutionary, new painting tool. See how the Ransburg Electrostatic Hand Gun can save time . . . paint . . . and cut costs in YOUR finishing department. If your production justifies, it'll pay you to investigate Ransburg's *automatic* electrostatic spray painting equipment. Write for our No. 2 Process brochures which show numerous examples of modern production painting in both large and small plants.

RANSBURG Electro-Coating Corp.
Box 23122, Indianapolis 23, Indiana

For more information, turn to Reader Service card, circle No. 427

PROPERTIES OF NO. 16075 O-RINGS

Property ↓	MIL-R-25897C	16075
Ten Str, psi	1600 min	2300
Elong, %	175 min	180
Hardness, Shore A	75±5	75

to high temperatures, aromatic fuels and hydraulic fluids. The developer says the compound was formulated to provide good compression set resistance under severe operating conditions.

The material, designated Grade No. 16075, can be extruded or molded into o-rings and other shapes. It is approved under military specification MIL-R-25897C. **KEY NO. 644**

Rosin Solder Flux for Electronic Use

A mildly activated rosin-type solder flux called Fusion RU has been developed by Fusion Engineering, 17921 Roseland Ave., Cleveland 12. The flux is suitable for electrical and electronic applications where nonconductive, noncorrosive flux residues are required. Humidity chamber tests show the flux is noncorrosive after soldering.

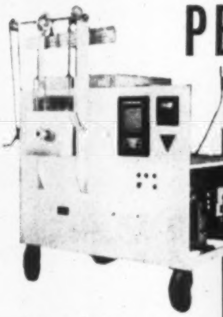
The developer says the flux can wet mild steel, brass, copper, tin, lead, and cadmium and silver electroplates. **KEY NO. 645**

Foam Plastic Sheet for Insulation, Packaging

Expanded polystyrene sheet combining several properties that make it suitable for packaging, thermal insulation and similar uses is now available from the Dyna-Foam Corp., Ellenville, N. Y.

A thin film of Dyna-Foam is said to provide efficient insulation against temperatures from −425 to 212 F. The manufacturer says that it is also very resilient, lightweight, waterproof, chemically inert, nonabrasive and decorative.

Films and sheets are available up to 60 in. wide and in lengths comparable to the largest paper rolls. Special shapes and thicknesses are



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for continuous operation at temperatures up to

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"Provides the Higher Temperatures now needed in experimental fabrication and heat treating studies"

That's what one of the country's foremost research laboratories states when reporting on the use of their new Pereco Kanthal—Super Element Furnace, illustrated above. Mounted on casters, this Model FGKS combines the accuracy and flexibility of heat control with the mobility of equipment so desirable in laboratory work. Tell us of your work requirement. One of Pereco's LINE of Kanthal Super Element Furnaces might be just what you need.

Standard or Special Furnaces for temperatures of 450 degrees F. to 5000 degrees F.

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Our varied and exacting manufacturing operation requires an imaginative and experienced Materials Engineering Supervisor. General activity involves application problems encountered in our unique manufacturing operations plus advanced R & D projects.

Our products require the whole broad spectrum of materials, including plastics, rubbers and metals. You'll need a firm background in epoxy, nylon, teflon, polyethylene, silicone, neoprene, polyurethane, aluminum, steel and a wide range of alloys. It is important that you have a thorough understanding of molding, potting, fabrication methods, welding, heat treating, processing methods, finishing, adhesives, cable, tape and similar items.

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We offer security, plus unusually generous company benefits, in a Midwestern community which is famous for its beauty and low cost of living. All replies will be strictly confidential.

For Personal Interview

Send Resume to:

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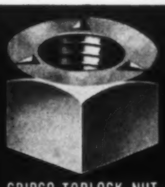
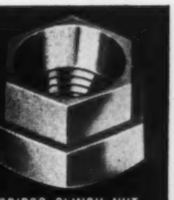
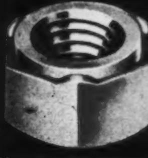


GRIPCO TOPLOCK NUT
One piece all metal.



GRIPCO CLINCH NUT
With or without self-locking threads. Hex collar prevents turning when torqueing bolt.



GRIPCO PILOT-PROJECTION WELD NUT
With or without self-locking threads. Centering collar positions nut and protects threads from weld spatter.

You get these "extras" when you specify GRIPCO® FASTENERS—

Service — 40 sales representatives all over the country for prompt, fast service.

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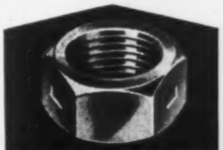
Speed production and lower costs on your products with this Grip Nut family of Gripco Fasteners. Qualified fastener engineers are available for consultation on all your assembly problems. Consult the yellow pages in your phone book under "Gripco" for the one nearest you.



GRIPCO CENTERLOCK NUT
Locking feature in the center for fast feeding. Can be applied from either end.

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With or without self-locking threads. Countersink protects threads from weld spatter.

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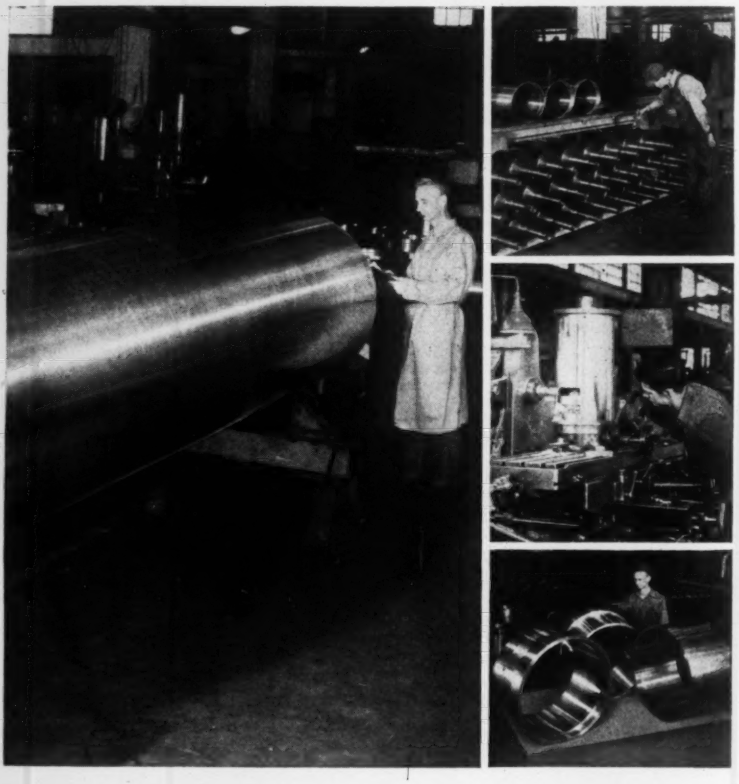

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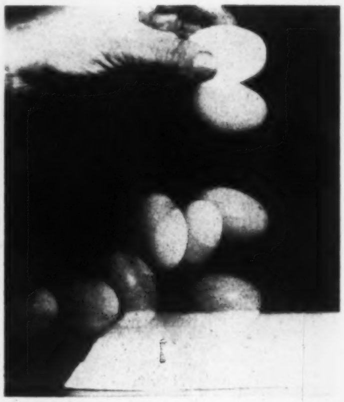

Resiliency *of a sheet of Dyna-Foam 0.08 in. thick is demonstrated by dropping a raw egg from a height of 1 ft.*

Fitted packaging platforms *for bottles and other breakables are made of Dyna-Foam expanded polystyrene. Custom-fitted packing can also be produced for such other items as candy, crackers and light bulbs.*

available for specific applications.

Dyna-Foam is made by vacuum or press forming at about 220 F from polystyrene pellets. Gas within the pellets expands and foams the plastic. KEY NO. 646

High Purity Silicon for Semiconductor Devices

High purity silicon in polycrystalline rod form is now being produced by Dow Corning Corp., Midland, Mich. The producer says the rods are produced by a method that assures greater purity than casting.

By vacuum zone refining, the polycrystalline rod can be converted to

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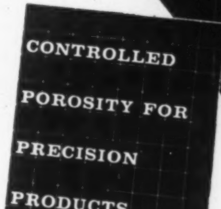

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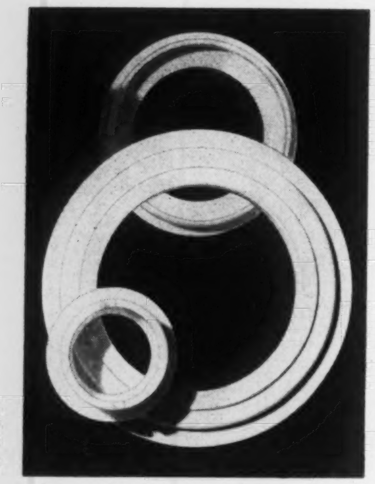

Corrosion and Abrasion Resistant Coors Ceramics Provide Long, Maintenance-Free Service Life

Mechanical shaft seal rings of Coors Alumina Ceramics give extended service life under severe operating conditions.

The extreme hardness and toughness of Coors Alumina Ceramics provide maximum resistance to abrasion.

In corrosive applications, seal faces will not pit or corrode, because Coors Alumina Ceramics are inert to almost all fluids.

Mechanical shaft seal units with Coors Alumina Ceramic parts are available only through seal manufacturers. For materials application, we stand ready to work with you in utilizing the unique properties of Coors Alumina Ceramics — prototype or production runs.

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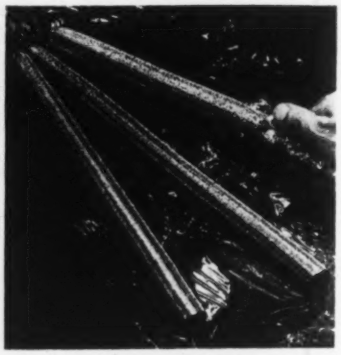
What's new IN MATERIALS



Silicon rods *have a high degree of purity and uniformity.*

single-crystal silicon having a resistivity greater than 1000 ohm-cm, and a minority carrier lifetime greater than 400 sec.

The rods are supplied in diameters up to 1 in. and in lengths up to 17½ in. They sell for about $300 per lb.

KEY NO. 647

RTV Rubber's Viscosity Lowered with Thinner

A new, inert silicone oil for adjusting and controlling the viscosity of RTV (room temperature vulcanizing) silicone rubber is now commercially available from Dow Corning Corp., Midland, Mich.

A big advantage of the product, called RTV thinner, is that it can be used to maintain an RTV system that is free from volatile solvents.

The material can reduce the viscosity of RTV rubber by as much as 75% without significantly changing the physical properties of fully vulcanized rubber, according to Dow Corning. **KEY NO. 648**

Large, Hollow Plastics Extrusions

Very large, hollow plastics extrusions are now possible as a result of a new extrusion technique (details not disclosed) developed by Anchor Plastics Co., 36-36 36th St., Long Island City 6, N. Y. An example of a part that can be made

LET'S LOOK IT UP
REINHOLD BOOKS

☐ **HOT ORGANIC COATINGS** *by Raymond B. Seymour.* Presents the constitution, applications and properties of hot organic protective coatings, including asphalt, coal tar pitch, petroleum waxes and cellulose derivatives. Extremely helpful to anyone using these coatings in any form. 1959, $7.50

☐ **INDUSTRIAL FATTY ACIDS AND THEIR APPLICATIONS** *edited by E. Scott Pattison.* This book covers the production and processing of fatty acids with emphasis on practical technology and the chemistry involved with it. The coverage also includes an up-to-date review of the chemistry, technology and applications of the derivatives having commercial importance. The book also reflects the growing industrial importance of fatty acids derived from tall oil. 1959, $7.00

☐ **SEMICONDUCTORS** *edited by N. Bruce Hannay.* An unrivaled, indispensable reference on the physical chemistry and fundamental physics of semiconductors, with detailed analyses of important semiconducting materials. The emphasis throughout is on basic principles and phenomena. ACS Monograph, 1959, $15.00

☐ **FRINGE BENEFITS** *by F. M. Wistert.* An all-inclusive coverage of the history, cost, and economic significance of known fringe benefits of regional, industrial or national importance, with forecasts of their further development. Here is a complete reference for labor and management personnel. 1959, $3.75

☐ **ENCYCLOPEDIA OF CHEMICAL REACTIONS,** Volume 8, *edited by C. A. Jacobson and C. A. Hamoel.* This monumental series, now complete with this volume, is the only work in existence attempting to list all the known inorganic chemical reactions published in existing literature. Volume 8 covers Tungsten, Uranium, Ytterbium, Yttrium, Zinc and Zirconium, plus 768 addenda entries on elements appearing in earlier volumes. 1959, $14.00

☐ **SILICONES** *by Robert N. Meals and Frederick M. Lewis.* Includes the manufacture, properties and applications of the silicones, with data on properties of silicone resins, fluids and rubbers at high temperatures. The book contains case histories of present industrial applications and many new ones. 1959, $5.95

☐ **ROCKET PROPELLANTS** *by Francis A. Warren.* Contains the composition, manufacturing methods, and performance details of both solid- and liquid-propellants used in rockets, from small signal units to the largest missiles being launched today. Also includes chapters on propellant burning, ignition and igniters, safety in propellant manufacturing plant, and quality control. 1958, $6.50

☐ **AN INTRODUCTION TO CHEMICAL ENGINEERING** *by Charles E. Littlejohn and George F. Meenaghan.* The emphasis of this new book is on the fundamentals which form the basis of chemical engineering theory. Among essential ideas developed are: the distinction between quantities of force and mass; the concept of enthalpy, derived and explained; and the ideal gas law, derived from basic considerations. The book stresses the many important concepts and tools which are often omitted or only summarily treated elsewhere. 1959, $7.80

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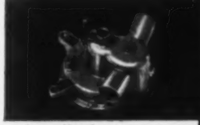

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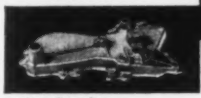

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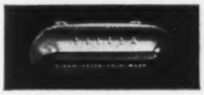

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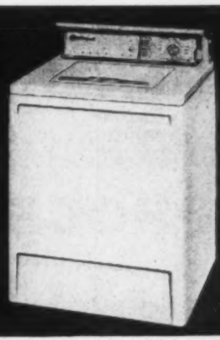

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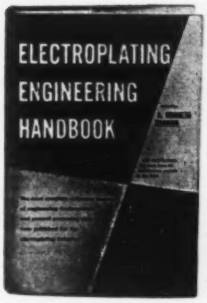

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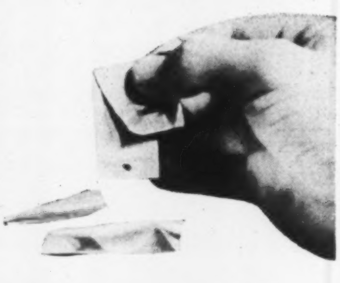

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What's new IN MATERIALS

***Typical part** that can be made by Anchor's new extrusion technique.*

by the process is a rectangular polystyrene tube measuring 3 by 7 in.

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Other News . . .

Metals

- Riverside-Alloy Metal Div. of H. K. Porter Co., Inc., Riverside, N. J. says it has added types 302, 304 and 316 to its line of Isoloy stainless steel spring wires. **KEY NO. 650**

- Stainless steel-clad welded carbon steel tubing is now available from Standard Tube Co., 24400 Plymouth Rd., Detroit 39. The tubing is supplied in sizes up to 3½ in. o.d., and in composite wall thicknesses up to ¼ in. **KEY NO. 651**

Plastics

- A line of wood-grained plastics moldings for use as trim has been introduced by Glass Laboratories Inc., 863 65th St., Brooklyn 20, N. Y. The moldings, called Silvatrim, are supplied in over 150 different cross sections. **KEY NO. 652**

- A new, low cost method for molding thermoplastics will be used by American Agile, Cleveland; Amos Molded Plastics, Edinburg, Ind.; Loma Plastics, Fort Worth, Tex.; Rubbermaid, Wooster, Ohio; and Space Structures, Inc., Chanhassen, Minn. for making large plastics products. The technique, described in the Mar '60 issue of this maga-

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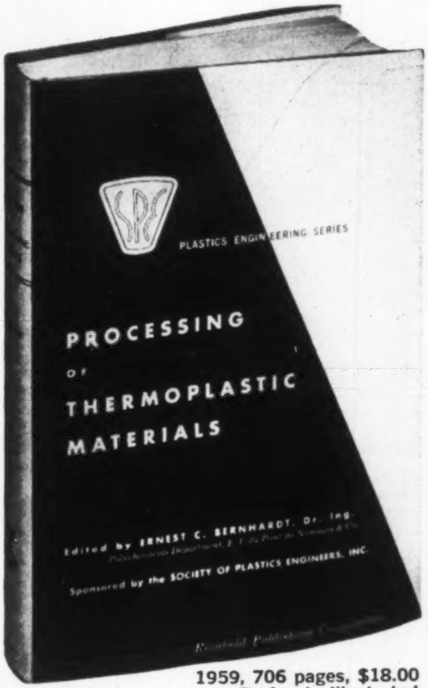
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Reinhold Publishing Corporation

1959, 706 pages, $18.00
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Here is a definitive, and the most extensive handbook ever published on the engineering problems involved in extrusion, injection molding, calendering and other thermoplastics processing operations. The book reviews the engineering fundamentals on which the design of plastics processing equipment is based, and demonstrates the practical application of these fundamental concepts in the analysis of thermoplastics processing problems. The text is developed simply and clearly, and is designed to help fill the need for a basic book on processing of thermoplastics. The book is aimed at engineers, but does not require the reader to possess previous knowledge of plastics processing technology.

Twenty technical authorities have contributed to this volume from first-hand experience, and fourteen plastics firms and universities have supported it by providing information, editors and authors.

Partial Contents and Contributors

SECTION I—Fundamentals

Flow Behavior—A. B. METZNER, Sc. D., University of Delaware

Heat Transfer and Thermodynamics—J. M. McKELVEY, Ph.D., Washington University, St. Louis

Mixing and Dispersing—W. D. MOHR, M.S., Massachusetts Institute of Technology

SECTION II—Applications

Extrusion—J. B. PATON, B.S.; P. H. SQUIRES, Ph.D.; W. H. DARNELL, Ph.D.; and F. M. CASH, B.S.: all of E. I. du Pont de Nemours & Co., Inc. and J. E. CARLEY, Ph.D., Modern Plastics, Breskin Publications, Inc.

Injection Molding—G. B. THAYER, B.S.; J. W. MIGHTON, B.S.; R. B. DAHL, B.S.; and C. E. BEYER, B.S. All of Dow Chemical Co.

Calendering—D. I. MARSHALL, Ph.D., Union Carbide Plastics Co.

Mixing and Dispersing Process—J. T. BERGEN, M.S., Armstrong Cork Co.

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SECTION III—Processing Properties

Processing Properties—R. F. WESTOVER, M.S.E., Bell Telephone Laboratories

About the Editor

ERNEST C. BERNHARDT supervises process development activities at the Sales Service Laboratory of the Polychemicals Department, E. I. du Pont de Nemours and Company, Inc. His technical publications have been primarily in the field of thermoplastics extrusion. He is a member of the Society of Plastics Engineers, and of the American Chemical Society. He received a B.S. in Chemical Engineering from Purdue University, his M.Ch.E. from the University of Delaware, and a Doctorate in Engineering from the TECHNISCHE HOCHSCHULE in Darmstadt, Germany.

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☐ **POLYAMIDE RESINS** *by Don E. Floyd.* Contains the basic chemistry and raw materials of polyamide resins, methods for their manufacturer, a definitive discussion of key properties, and information on all important applications. These latter include fibers and filaments, coatings and films, moldings, extrusions, adhesives, inks, castings, and sealants. 1958, $4.50

☐ **POLYURETHANES** *by Bernard A. Dombrow.* Contains the chemistry and applications of these materials. The latter includes rigid foams, semi-rigid foams, flexible foams, rubbers, adhesives, coatings, textiles, and miscellaneous applications. Includes an important chapter on the handling of diisocyanates. 1957, $4.50

☐ **POLYETHYLENE** *by Theodore O. J. Kresser.* Covers this exciting new material in respect to its uses and why it is frequently preferable to other materials. Emphasizes a practical and selective method which features representative applications with a liberal use of illustrations. Includes recent advances in the field, and their fututre importance to industry. 1957, $4.95

☐ **CONCISE GUIDE TO PLASTICS** *by Herbert R. Simonds.* Every practical question you have about the uses, properties, cost, or sources of all plastics is specifically answered in this truly indispensable book. A striking feature lists the 43 most important plastics producers and all pertinent information including their addresses, products, trade names, etc. 1957, $6.95

☐ **CHEMISTRY OF NATURAL AND SYNTHETIC RUBBERS** *by Harry L. Fisher.* All commercial rubbers and their properties are surveyed in this book by one of the world's leading authorities on the chemistry of rubber. Covers chemistry of elastomers, vulcanization, acceleration antioxidation and antiozonation, natural rubber, latex, properties of natural and synthetic rubbers, some raw materials for, and synthetic rubbers, hard rubber, bonding rubber to metals, reclaimed rubber, and chemical derivatives. 1957, $6.50

☐ **PLASTICS ENGINEERING HANDBOOK of The Society of the Plastics Industry, Inc.** Contains exhaustive, well-arranged engineering information on the design, materials, processes, equipment, finishing, assembly, testing and standards of plastics and plastic products. Entirely rewritten, this new edition of the famous SPI Handbook is almost twice its former size. Suppliers of raw materials will find a complete set of accepted standards and specifications. Designers and engineers will find new testing methods fully described. Users of plastics will welcome the standards for testing, rating, certifying and labeling plastic commodities. **1960, $15.00**

☐ **ENCYCLOPEDIA OF CHEMISTRY** *edited by Clark and Hawley.* The first complete, multi-author one-volume reference covering a broad spectrum of chemically important subjects. Over 800 articles, 500 contributors, and 1,000 pages of remarkably condensed, authoritative information on modern chemistry from Abrasives through Zirconium. No other single volume offers so much to all workers in chemistry and in the dozen or more sciences that border on it. 1957, $19.50

☐ **SOURCE BOOK OF INDUSTRIAL SOLVENTS** *by Ibert Mellan.* To be published in four volumes, this series arranges all the known solvents according to distillation point. For each solvent, a wide spectrum of properties is given in time-saving, tabular form.
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☐ **QUALITY CONTROL FOR PLASTICS ENGINEERS** *edited by Lawrence M. Debing.* Introduces the subject of statistical quality control to plastics engineers and manufacturers. The book refers specifically to applications currently used in industry, and shows how to use basic statistical procedures in achieving highest possible standards of performance. 1957, $4.95

☐ **FIBERGLAS REINFORCED PLASTICS** *by Ralph H. Sonneborn.* The first complete treatment ever published on reinforced plastics. Covers in full detail the resins and glass reinforcements used, molding techniques, inspection and testing, properties and design considerations. Provides all those concerned with reinforced plastics with valuable information never before available in one compact volume. 1954, $4.50

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What's new IN MATERIALS

zine (p 10), works by fusing thermoplastic materials together in inexpensive molds. **KEY NO. 653**

▶ Cast Optics Corp., 1013 Newman St., Hackensack, N. J. has introduced cast acrylic corrugated sheets in a variety of colors. The sheets are called Evr-Kleer. **KEY NO. 654**

▶ Dorak Products Corp., 78 Pearl St., New York 4 is marketing vinyl and polypropylene perforated sheets. Called Filter-Mesh, the unplasticized materials can be used to filter acids, alkalis, solvents and salt solutions. **KEY NO. 655**

▶ Six new large sheet sizes of Formica laminated plastics have been announced by Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio. The new sheet sizes are 30, 36, 48 and 60 by 144 in., 60 by 96 in. and 60 by 120 in. **KEY NO. 656**

▶ A new polyethylene resin is said to produce film of exceptional clarity and high gloss. The resin, designated Petrothene 218, is marketed by U. S. Industrial Chemicals Co., Div. of National Distillers and Chemical Corp., 99 Park Ave., New York 16. **KEY NO. 657**

▶ A clear, fully transparent vinyl tubing that shrinks under heat to provide a tight covering for either symmetrical or gently contoured shapes is now available from Irvington Div., Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. The tubing, called ScotchTite, has previously been available only in black. **KEY NO. 658**

Other nonmetallics

▶ A low cost, low density insulating fill is now available from Johns-Manville, 22 E. 40th St., New York 16. The material, called Perlox, is especially suitable for insulating liquid oxygen and liquid hydrogen. **KEY NO. 659**

▶ Two new thread sealants for storable rocket propellant systems are available from Redel Inc., 220 N. Atchison St., Anaheim, Calif. Reddy-Lube No. 100 is compatible with nitrogen tetroxide and Reddy-Lube No. 200 is compatible with dimethyl hydrazine. **KEY NO. 660**

▶ A highly stable, concentrated dispersion of colloidal, molybdenum disulfide in isopropyl alcohol has been developed by Acheson Colloids Co., Div. of Acheson Industries, Inc., Port Huron, Mich. The dispersion, called 'dag' No. 210, is said to form a tightly adherent film on a variety of substrates. **KEY NO. 661**

▶ A heavy weight, high wet strength paper is available from Paterson Parchment Paper Co., Bristol, Pa. for use as casings in oil filters and as tags. The paper is supplied in sheets and rolls in widths up to 72 in. **KEY NO. 662**

▶ A line of ceramic shapes, including bushings, washers, rods, disks and plates, for use at temperatures up to 2100 F is being marketed by Duramic Products, Inc., 426 Commercial Ave., Palisades Park, N. J. The ceramic material (composition not disclosed) is said to have excellent thermal shock resistance. **KEY NO. 663**

▶ Carey-Canadian Mines, Ltd., P.O. Box 95, Cincinnati 15, Ohio has introduced two new asbestos materials for reinforcing plastics. The fillers are called 7RF-9 and 7TF-8. **KEY NO. 664**

Finishes

▶ A heat resistant paint for protecting steel jigs, fixtures and formed steel products during brazing and welding operations has been developed by Speco, Inc., 7308 Associate Ave., Cleveland 9. Known as Heat-Rem H-170 Super, the paint is said to withstand temperatures up to 1700 F. **KEY NO. 665**

▶ John L. Armitage & Co., 245 Thomas St., Newark 5, N. J. has developed a clear thermosetting coating for use in vacuum metallizing plastics parts. A base coat is first applied to a part, baked, then vacuum metallized. A top coat is then applied over the metallized part and baked. **KEY NO. 666**

▶ A clear urethane coating is said to restore high gloss to rubber products dulled by manufacturing processes. The coating, developed by Cosden Paint Co., Beverly, N. J., is said to have the ability to elongate as the rubber stretches, and then return to its normal state without cracking or checking. **KEY NO. 667**

▶ CuSol is the name of a new plating process that is said to deposit a copper electroplate having good ductility and smoothness. The process, developed by Seymour Mfg. Co., Seymour, Conn., can be used to plate steel, zinc, tin and other metals. A CuSol plating solution is said to be stable and free of break-down products. **KEY NO. 668**

Fastening

▶ Project Fabrication Corp., 112-20 14th Ave., College Point 56, N. Y. is marketing a metallurgically bonded stainless steel-aluminum coupling for joining stainless steel pipe to aluminum pipe without flanges or gaskets. **KEY NO. 604**

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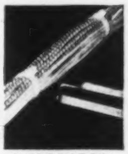
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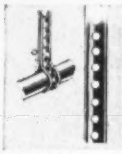
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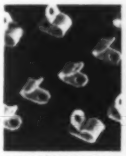
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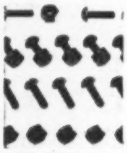
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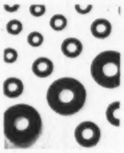
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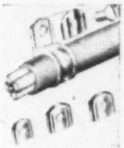
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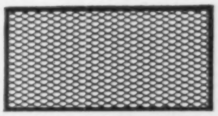

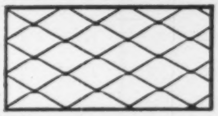

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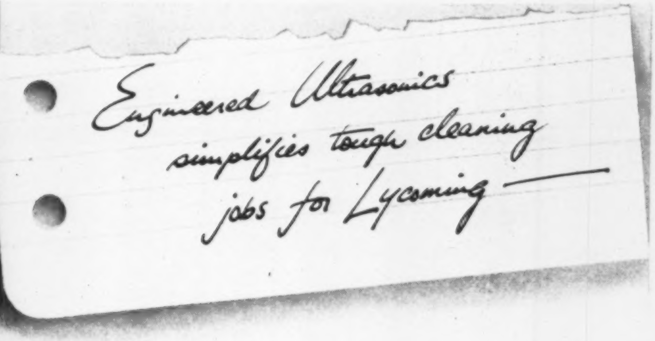

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THE LAST WORD

Do We Need a Plastics Institute?

by H. R. Clauser
Editor

For a number of years this question has been asked and discussed by a great many people concerned with the production, processing and application of plastics. Now, developments in recent months seem to indicate that the question will soon be answered one way or the other.

Committee surveys support

During the past year, a committee made up of people from various segments of the plastics field has developed a definite plan for establishing a Plastics Institute of America, and it has been working hard to gain the necessary support for the project. Two industry-wide surveys have been completed and a third is underway. Briefly the Institute, as outlined in the prospectus, would be an industry-supported research, education and information center whose major objectives would be to advance the frontiers of knowledge of plastics and to increase the supply of plastics engineers and scientists.

Plastics societies not in accord

Thus far the committee reports that the results of its surveys have been definitely encouraging. However, as is to be expected when an industry-wide project of this magnitude is proposed, there are differences of opinion. These differences are best seen, perhaps, in the stands taken by the two major plastics organizations. Strong support for the Institute has come from the Society of Plastics Engineers, which has contributed $8000 toward the initial expenses entailed in exploring and publicizing the project. The Society of the Plastics Industry, Inc., on the other hand, has not given its support to the project.

Though officially SPI has taken a neutral position, judging from the content and wording of a six-page "general bulletin" it issued in August there can be little doubt as to where SPI really stands on the issue. Nowhere in the bulletin is SPI's position directly stated. But a series of questions and answers attempts to show that present research and educational efforts are quite adequate, thus leading the reader to conclude that there is no need for a Plastics Institute.

Users and producers differ on need

The different positions taken by SPE and SPI on the Plastics Institute question are largely reflections of the differences in the membership and character of the two groups. Thus, SPE is heavily oriented towards plastics converters, processors and users who have most need for the kind of help a Plastics Institute would provide. On the other hand SPI has greater representation among the basic materials producers. The materials producers have extensive research facilities and programs of their own, and apparently feel that the benefits they would derive from a Plastics Institute would not be worth the additional financial outlay.

We have previously expressed ourselves in favor of the Plastics Institute (see M/DE, Nov 1959, p 256). We believe that group research of this kind benefits all—plastics producers, processors and users alike. The Institute plan offers a sensible solution to the many small and medium-size companies who need the results of research but who cannot afford to go it alone. The Institute would minimize duplication of effort in many areas, e.g., in evaluating performance properties and developing testing methods and standards. And it would serve as a focal point for studies on the fundamental structure of polymers, which would lead to improvements in production, processing and application of plastics, and in turn to greatly expanded use of plastics.

Companies benefit from industry progress

Finally, in evaluating the pros and cons of a Plastics Institute, it might be worthwhile for the plastics industry to look over the fence at the experience of the metals field. Until recent years most companies in the metal producing industries went their separate ways in research. Except where defense money was available, progress was slow and little fundamental research was undertaken. Only after other materials started to make serious inroads into their markets did the metal producers come to accept the general rule that the healthy progress of individual companies depends in large measure upon the progress of the industry as a whole.

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